United States
Environmental Protection
Agency

Office of
Public Affairs (A-107)
Washington DC 20460

Volume 10
Number 4
May 1984

EPA JOURNAL

Secrets of the Forest

Another challenge for
EPA's research program

Research Challenges at EPA

Scientists at EPA's Environmental Research Laboratory in Corvallis, Ore., check for ozone damage on pine seedlings in the laboratory's greenhouse facility.

Solving today's complex environmental problems requires a lot of facts as well as action. In this issue of EPA Journal, the research that underpins environmental decisions is explored.

An overview of research at EPA is provided in an interview with Dr. Bernard Goldstein, a physician and research scientist who is now Assistant Administrator for Research and Development. As an example of advancing EPA research, an article describes a project to monitor the actual daily exposure of people to toxic substances in their normal environment.

Reports from the agency's 14 laboratories describe a wide range of research targets, from ground-water contamination to the risk of pollution-related heart disease.

The major effort being launched to understand pollution's role in a forest die-back in the eastern United States is explained by EPA Administrator William Ruckelshaus in testimony to Congress.

A renowned scientist and specialist in the dangers of asbestos, Dr. Irving J. Selikoff of the Mount Sinai School of Medicine in New York, discusses the lessons to be learned from the asbestos tragedy.

A photo essay portrays activities by EPA specialists to cope with a mock nuclear power plant accident in Florida.

EPA's research to help the agency deal with the highly toxic chemical, dioxin, is explained in an interview with Erich Bretthauer, who represents the Office of Research and Development on EPA's Dioxin Management Task Force. Seven other highlights of science at EPA are described in an article by Richard Laska, a writer for the agency. The role of research behind the Administrator's recent proposals for a new standard for particles in air is detailed in another article.

A look at another EPA science resource—the Science Advisory Board—is provided by Dr. Norton Nelson, Chairman of the Board's Executive Committee and a professor of environmental medicine at the Institute of Environmental Medicine, New York University Medical Center.

The results of EPA's program to test the potential of cleanup technology and help industry adopt more efficient control methods are explained in an article by Susan Tejada, Contributing Editor of *EPA Journal*. The two-fold benefits of cost savings and cleaner air from research sponsored by EPA and being adopted by industry to control volatile organic compounds are described in a piece by Carl Gagliardi, an EPA press officer. Activities to support a chief EPA goal—good risk assessment—are explained by Dr. Elizabeth L. Anderson, Director of the Office of Health and Environmental Assessment.

In a recent speech to the National Wildlife Federation, Administrator Ruckelshaus reviewed progress made in the first year of his second term as Administrator. Excerpts from his comments are included.

Eight new appointments at the agency are reported, along with news summaries in Update, a feature on new agency developments.

The link between the horseshoe crab and shore birds on the beaches of Cape May, N.J., is reported in Environmental Almanac. □

United States Environmental Protection Agency
Office of Public Affairs (A-107) Washington DC 20460
Volume 10 Number 4 May 1984

EPA JOURNAL

EPA is charged by Congress to protect the Nation's land, air and water systems. Under a mandate of national environmental laws, 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.
The EPA Journal is published by the U.S. Environmental Protection Agency. The Administrator of EPA has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Agency. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget. Views expressed by authors do not necessarily reflect EPA policy. Contributions and inquiries should be addressed to the Editor (A-107), Waterside Mall, 401 M St., S.W., Washington, D. C. 20460. No permission necessary to reproduce contents except copyrighted photos and other materials.

Front Cover: Spring brings pale green leaves to a West Virginia forest near Harpers Ferry. Photo by Linda Bartlett of Folio. (See story on page 18)

Photo Credits: Linda Bartlett of Folio; Steve Delaney; Vermont Travel Division, State of Vermont; Schecter Me Sun Lee; Washington Suburban Sanitary Commission; Chemical Week; and Charles O'Rear, EPA-Documerica.

Design Credits: Robert Flanagan; Ron Farrah.

EPA JOURNAL Subscriptions

The annual rate for subscribers in the U. S. for the EPA Journal is $20.00. The charge to subscribers in foreign countries is $25.00 a year. The price of a single copy of the Journal is $2.00 in this country and $2.50 if sent to a foreign country. Prices include mail costs. Subscriptions to EPA Journal as well as to other Federal Government magazines are handled only by the U. S. Government Printing Office. Anyone wishing to subscribe to the Journal should fill in the form at right and enclose a check or money order payable to the Superintendent of Documents. The requests should be mailed to: Superintendent of Documents, GPO, Washington, D.C. 20402.

Name-First, Last — Please Print

Company Name or Additional Address Line

Street Address

City — State — Zip Code

☐ Payment enclosed
(Make check payable to Superintendent of Documents)
☐ Charge to my Deposit Account No.

Research at EPA: An Interview with Dr. Bernard Goldstein

This is a special EPA Journal interview with Dr. Bernard Goldstein, Assistant Administrator for Research and Development at EPA. A physician and research scientist by profession, Dr. Goldstein has been in his post at EPA since November 1983.

Dr. Craig McFarlane, right, an environmental scientist at EPA's Corvallis facility, describes to Dr. Bernard Goldstein the use of an exposure chamber for measuring the uptake of toxic substances by plants.

Q What are some of the major problems that environmental research needs to address over the next ten years?

A If we look at broader context type of issues, certain things pop out. For example, we are going to have to know better how people are exposed to environmental contaminants. We do a good job of interpreting the intrinsic hazard, the possibility that an adverse effect may occur due to a compound. We don't do as good a job of finding out the extent to which this compound is actually affecting the public.

Exposure is a broad over-arching area that we have to look at, and it will require research in a number of different media. In terms of air and water a number of different approaches will be required. We need better models as to how people get exposed, and how environmental targets get exposed. We need better ways of measuring pollutants in air and in water and in the soil. We have to start taking advantage of some of the newer advances in biological monitoring.

We need to explore some of the new wizard-like technology that people read about in the papers, in terms of making new genes and things along that line. These approaches may actually open up the opportunity to detect very small changes in normal human constituents, and, perhaps, even detect the chemical that's causing these very small changes that is now attached to, say, the human red blood cell.

If we can develop these new techniques, we can, perhaps in the next decade, be in the situation of really knowing how much people are exposed. We may really be able to know whether someone living next to a toxic waste dump has had more of an exposure than someone living somewhere else. We may really be able to detect the amount of diesel exhaust constituents that are attached to a person's blood cell during the four months that such a cell usually survives.

This would give us a much better handle on exposure than we have right now and allow us to make a lot more appropriate decisions as to what really is affecting people, what really is getting into the human body and is capable of causing adverse health.

Q What else should environmental research focus on in the next decade?

A We have to understand better how things move through the environment. The ground-water problem is a classic example.

We don't really understand as well as we should how a chemical at an industrial plant eventually gets into a glass of drinking water somewhere, perhaps hundreds of miles away. How do these things move through our society? It's a little easier to understand in air and water than it is in the soil.

We are going to have to know a lot more in the next decade about certain parts of our ecosystem. For instance, there is some recent information suggesting that there may be a significant die-back in American forests up and down the whole East Coast.

We just don't yet know enough about the die-back to be able to ascribe a specific cause — to say, "Ah, this must be due to acid rain, or this must be due to ozone." It could be due to some natural cycle that occurs in nature for reasons unrelated to air pollution. We must know the inter-relationships of all the various things that go into producing a forest and how pollution fits into that relationship.

Q What about research into conditions that make pollution worse than it would be alone?

A We are going to have to start doing more to understand the stress that a pollutant causes in relation to the total stresses that are present in an environment that are not due to pollution — the weather, insects, things along that line which can also have effects, but which we tend to think of independently of pollution's impact.

We also have to start spending a lot more time and effort in the area of interactions of pollutants. For instance, we know that even though we do our research for the most part with one chemical at a time, in fact in the real world there are multiple pollutants all occurring at the same time. Some are in air and some are in water.

There's now, for instance, a body of evidence developing that says if you give a laboratory animal some alcohol in drinking water, equivalent to a couple of beers a day, it is going to react differently to a pollutant. That's telling us that we have to be very alert to potential interactions.

Of course, we can't look at every possible interaction. This brings up the subject of mechanistic research. If it's going to be important for us to generalize from one group of chemicals to another, then the only way that that generalization can really work in a manner that's going to protect the public is if we understand the mechanism by which chemicals cause damage. It's not just counting the bodies, if you will, measuring the adverse effects, but being able to state why the adverse effects occur, because when we understand this, we can then be much more predictive about the next chemical that comes along that might also produce the same effect.

Q Is the kind of research you're talking about longer range, more in depth, and if it is does EPA have the funding stability to sustain it?

A Funding stability is always a problem, and I'm not going to try to predict it for ten years from now. One of our biggest problems as an agency has been the fact that we have not had sufficient stability in our laboratory research program to be able to do the research that we would want to do, and, in fact, even research that we had planned to do.

You just cannot mothball an experiment. You can't stop an experiment in the middle without really losing a lot of what you have invested. So stability is very important. But by the same token, when you do science in a regulatory agency, it means that you will be responding to the needs of the public; and if an unexpected problem comes up, and the public says, "We want a lot of attention devoted to this particular topic because we are concerned about it," it is appropriate for the regulator to ask the scientists to stop what they are doing and to address this new area.

In a regulatory agency you do need the flexibility to respond to what the public wants, and that's appropriate. But it's part of the job of management, of the regulatory agency, of the Office of Research and Development, to make sure that when we do change what we are going to do that that cost is factored in, that we realize what the costs are. We should only pull scientists away from what they're doing to do something else if there's a real need for it, that will overcome the cost of what we're losing by not having the scientist continue the original research.

Q Could a better job have been done on acid rain if the crucial questions had been asked early enough so that the research could have been done?

A Yes. For example, I've been informed that from the mid to late 1970s our research people continually requested funding to develop the monitoring techniques to measure the deposition of acid rain, and they were turned down because it was simply not a high enough priority.

I would suggest that in retrospect that was the wrong decision, and it demonstrates that we must be looking far enough ahead.

Q How can EPA be sure it is looking far enough ahead in its research?

A Right now we're going through a strategy exercise where each of the program office assistant administrators and myself are sitting down with our senior staff and writing a priority, a strategy document. We're beginning the Fiscal Year 1986 planning cycle, and we're not only asking for an agreement between the research and development senior staff and the program office senior staff on what the priorities should be for 1986, we're asking at the same time about 1990.

So we're doing both simultaneously. We intend that when the research committees set up their research priorities for 1986, that they also look ahead to 1990 and say, yes, it's true this is important for 1986, but here is something that really deserves a little bit of a higher priority because even though it isn't that important in 1986, look how it becomes more important in 1990, and if we don't start in 1986 we're not going to know by 1990.

The concept is that we have to not only be asking ourselves what are the issues for the very next year, but what are the issues for a couple years down the road so we're not going to get blindsided as we have to some extent by the acid rain issue and by other issues in not being able to provide answers to the questions that the Administrator and the public are asking.

Q When are we going to know enough to actually step in and control acid rain?

A That's a two part question in a sense, and people have to keep that in mind. You're really asking a question that has risk assessment and risk management aspects.

Knowing enough depends on what context. For instance, I'm a physician. If I dealt with a situation where someone may or may not have a disease for which I have a medicine which has no side effects to cure that disease, I don't need much information to show that the person has a disease before I give the medicine.

On the other hand, if I'm dealing with a situation where the medicine has severe side effects, or the potential for severe side effects, I'm not going to give the medicine for that disease until I'm much more certain about the fact that the disease is really present.

We're dealing with that kind of situation in acid rain. If, for instance, it costs a dollar and a quarter to clean up all the sulfur oxides and oxides of nitrogen that are present in the air, and maybe causing acid rain, we would have spent this as a society. We have enough information now to say, sure we'd spend a dollar and a quarter.

If it would cost the entire gross national product, we would also get complete agreement from everyone, no, we're not going to spend the entire gross national product on this issue, because, you know, we simply don't have enough information.

You obviously have to put these considerations into the equation. And you have to know what the people are feeling about these things before you say that there is enough research. That's really the risk manager's decision.

Q What is the job of research in these tough environmental issues?

A It's our job in research and development to keep on doing the crucial experiments, to resolve the uncertainties, to continually be interpreting the results as we get them, to be letting the Administrator and the public know what the boundaries of our uncertainty are, to be able to say what it is that the research seems to be telling us, what the data seem to say, and with what degree of uncertainty.

So, again, to get back to the analogy of the person who's got the disease. I want to know not only whether the testing indicates the disease, but how sure I am about that before I do the management approach of giving a dangerous medicine.

Now, I don't know at what point the manager will decide that this risk is something that ought to be handled with this particular type of management tool. It will all depend on what kind of management tools are available. My suggestion is that if the management tool consisted of spending a dollar and a quarter, it would have been done by now. It's not our job to tell the manager that. That's not an R & D job, it's really, if you will, a regulatory policy decision to say we know enough.

The job of R & D is to determine what the crucial experiment is, so as to answer the questions that are related to the mission of EPA.

Q How does EPA research stack up with academic research in facing such questions?

A I've been very pleased by the fact that the research that I've seen in our laboratories has, if anything, less of the kind of intellectual stagnation that one frequently sees at universities, where people just plan next year's research based on what they are doing this year, without any real attention to the questions that they are asking and the crucial information they may need.

Q Do public fears about environmental dangers usually tally with science's conclusions or is one or the other way off?

A It's not unusual that there will be differences among scientists and the public. Coming out of a medical background I think it's certainly no different than one sees in a medical situation: sometimes the degree of public alarm is beyond what seems to be appropriate from a medical point of view and sometimes less. We certainly ought to have much more concern about cigarette smoking and seat belt use in our society than we have.

Q Is it possible to be honest and factual in assessing the risk of pollutants without being biased toward industry or public opinion?

A It's definitely possible, and should be done at all times. That's what the Administrator means when he talks about separating risk assessment and risk management. He's asked that the risk assessors, and in this case we're talking about the Office of Research and Development, should be assessing risks and providing the information so that the managers can manage the risk. And by the managers I mean the program offices and obviously the Administrator and the Deputy Administrator.

There's a clear-cut distinction between assessment of risk and management of risk. There are times when it gets a little fuzzy. There are small points where it's difficult to sort out the differences. But I'd say for 99.99 percent of what we do it's clear that we're assessing the risk, we're not managing the risk, and it's clear that that assessment of the risk must be done independently of our own personal biases, independently of what the program offices might want us to say, and independently of what somebody might have voted us to say.

The science must be done in such a way that the manager can really rely on getting an unbiased point of view, an unbiased assessment of what we know and what we don't know and how sure we are of what we do know. Then they can use that information in managing.

Q Are researchers inevitably part manager when they assess risks?

A It's important not only that we do not distort the science, but that we don't try to play the role of policy makers. We are not policy makers. We should not, for instance, write a paper for a scientific journal having to do with, say, the levels of a pollutant in a given area, and conclude our journal article by saying therefore that we ought to take the following management approach.

Q In addressing current problems like EDB and dioxin, is there a gap right now between what we know and what we need to know?

A It's what we need to know that counts. You can argue that in terms, for instance, of EDB we really know what we need to know on that substance and that you've seen the Administrator work: get the information, put it together, and go forward with that information. In retrospect, we should have been doing a lot more research on EDB about ten years ago.

On dioxin there's a lot of things we do know; there's a lot more that we need to know. I can give you a whole lot of research needs for dioxin that would fill up a document in and of itself. As we discussed when we talked about acid rain, the decision as to when we have enough information is a management decision, not a scientific one.

Q What do we need to know about dioxin?

A A major research concern with dioxin is how to get rid of it. We know it's there. But simply banning it doesn't do any good. It's not like EDB where it's made for use in commerce and you just can simply prevent it from being made for that purpose. Here we've got the stuff lying around in unwanted places. How do we get rid of it, and how do we get rid of it in a way that doesn't cause other potential damage to the public? That's a very legitimate area for research.

Obviously, we could decide that to get rid of dioxin would require digging it up, putting it in a truck and carrying it cross country. However there are certain risks associated with each of those actions. So we've got to think of ways to remove dioxin which will cut down on the overall risk.

Then of course we've got to know more about how dioxin gets formed. It's formed in burning processes. So we must know more about that so we can prevent its formation.

We have to know more about the real risk of dioxin to man—how much of a likelihood is it that dioxin will cause cancer in man or cause other effects?

We have some data from which we're extrapolating, but we could do a lot

Dr. William Hogsett, a plant physiologist at the EPA Environmental Research Laboratory in Corvallis, Ore., discusses the use of open top chambers to study long-term effects of ozone on hay crops with Dr. Goldstein.

better than we are doing right now if we had some more research on the subject. It might lead us to a lot more certainty about what the limits of the effects were. Such research would make our decisions about how to get rid of dioxin, how to prevent it, and how much money to spend on it, a lot more firmly grounded.

We have to know more about how long dioxin persists in the environment. What difference does it make where it is in the environment as to how long it will persist? Will it get into ground water; how does it move through our environment?

Q You seem to be suggesting that we can find the answer to these modern day environmental dilemmas.

A Philosophically there are some answers which you can never ever get, but in terms of the kinds of questions we are asking here at EPA, for the most part we can reasonably expect that there will be answers if we want to devote the resources to the questions.

Sometimes the answers won't get there quickly enough for us to do something about them in the near term, and there will be problems like dioxin where we can't and we should not wait until we know every single thing there is to know before we proceed further.

We don't want to say that the fact there's one more experiment we can do means that there's a reason for the manager not to act. But again, this is a management decision.

In the six months or so that I've been in this agency, I have been impressed by how often I have seen the program offices wrestle with a decision for which there could have been an answer, had the question been asked in time.

For so many of the questions that I've seen the program offices wrestle with, further information could have helped them with their selection of options. If the question had been asked a few years ago, we'd have had the answers for them now.

So clearly, the important role of the Office of Research and Development is to be able to work with the program offices in anticipating what their questions are going to be a few years from now.

Q Based on what we've learned so far, are we going to be able to deal with ground-water contamination?

A We can deal with it to some extent right now. Again, it's a question of how are we going to go about doing it. And dealing with it is a concern for the most part of the Office of Water and they've certainly put a lot of effort into this area.

At the Office of Research and Development, we've had an integrated, almost a matrix type of approach to ground water for a number of years now. Obviously the research needed cuts across a number of different disciplines. For instance, how do compounds move through the environment to get into ground water? To answer this, we have to know a fair amount about just the normal hydrology of ground water. We have to know about soils, because we're usually talking about putting something down on the soil and then it ends up in the ground water.

We have to know about how compounds change as they move through the soil. We have to know what their residence time is. Obviously a compound that will decompose almost instantaneously when it hits the ground is not a compound we worry about in terms of ground-water problems, but other compounds which stay around for a long time are of concern.

We have a trade-off in that compounds that tend to be water insoluble such as PCBs and DDT tend to stay in our environment for quite some period of time. What that means is that the compounds that are not water soluble are less likely to get into our water, but if they do, they'll tend to do different things than will the usual water soluble compounds.

There's a whole range in degree of water solubility or non-solubility, and soils attract different types of compounds depending upon their chemical characteristics. So you have to know about the chemistry of the compounds that you're dealing with to be able to predict what's going to happen, to really be able to link up the chemistry of compounds with their action in soil and water so you can get some predictive ideas as to the potential ground-water problems.

Q Do you see a role for EPA in stimulating new cleanup technology on the part of industry through research and development work?

A Definitely. A very major role. We've worked closely with industry. There are a number of approaches being used right now that came out of basic findings in our control technology laboratories, where the labs have developed the concept and then in cooperation with industry have eventually turned it over to them to make the salable item that is now being used commercially to keep the environment clean.

Q ORD has quite an extensive research apparatus. Is there overlap or is everybody working on separate things?

A There is some overlap, and it's the kind of thing which we have to be very careful about. If you go to business school and you learn a management type of approach, overlap is always considered to be very negative.

From a scientific point of view, though, overlap is something that's relatively positive as long as it doesn't go too far. You want some overlap.

The area I'm most familiar with is health research. You can look at the most dynamic types of health research and you will find that there's tremendous overlap and it's through this overlap, this continual feeding back and forth of ideas from different people occurring at national meetings and international meetings and through the mechanism of publications that the dynamic areas have really gotten where they are. The same thing is necessary if you are going to develop a program for the EPA. No, we don't want overlap that's unnecessary, but I'm not afraid of overlap in science in the same sense that I would be if we had overlap in our managerial functions.

Q You come from the scientific community. How do you like being an administrator in a government agency?

A I must say when I visit the laboratories and I sit through the one or two day briefings that they prepare for me on the research that's going on, that to me is the most fun I have.

Listening to good research, and there's just some outstanding research going on in the EPA laboratories, is exciting. I find if I spend too much time in Washington, and I don't hear about research I start getting a little unhappy with the job.

Q Is there anything concluding this interview that you would like to add?

A A bottom line is that I have been so impressed with the dedication of the scientists at EPA to the mission of the agency. The fact that they are really and truly working beyond the usual hours shows greater concern than you find in most research groups. They really are concerned about the environmental problems that they're trying to find the answers for. One comes back from a visit to the laboratory with a renewed sense of dedication.

It's again a reminder of the fact that the most important work in research and development is not being done here in Washington, but in the field, in the laboratories. Our job in Washington is to facilitate what is happening out in the field and to make sure the communication occurs with the program offices and with the scientific community so that we can let people know what's happening. □

Measuring Human Exposure to Toxics

Dear Californian:

The United States Environmental Protection Agency is currently conducting a study of exposure to toxic substances in your area. This study, known as the Total Exposure Assessment Methodology (TEAM Study), is being carried out by Research Triangle Institute (RTI), from North Carolina. As part of this study, a representative of RTI recently interviewed a member of your household. Based on the information collected during this interview and several hundred others in your area, a sample of persons was selected to participate in this most important study.

A letter further explaining the study was left at your household earlier, and another copy is enclosed. Within the next few weeks, an RTI Field Interviewer, who will display an RTI identification badge, will contact you to explain more about the study and your participation in it. With your permission, the interviewer will conduct a short interview, and set up an appointment for the collection of the samples listed in the explanatory letter.

Your random selection makes you the representative of many of your neighbors and other persons like you. Your cooperation in this important study is therefore vital and I urge you most strongly to agree to participate when the interviewer contacts you. Any further questions that you have will be answered by the interviewer.

Thank you very much for your concern and cooperation.

Sincerely yours,

William D. Ruckelshaus
Administrator

Approximately 75 citizen volunteers in the California communities of Antioch and Pittsburg, near San Francisco, will wear personal air sampling equipment *for a day to help monitor their normal* exposure to toxic substances in their environment. A companion study is being conducted with 175 Los Angeles residents.

These two locales, Antioch/Pittsburg and Los Angeles, were selected both for what they have in common — community interest and cooperation and oil refining and chemical manufacturing operations — and, what they don't — meteorological conditions and vehicle traffic patterns.

These activities are being conducted as part of an EPA study to test a methodology for estimating the distribution of exposures on an entire community to a number of pollutants. The project is known as the Total Exposure Assessment Methodology (TEAM) study.

"We will be analyzing people in normal activities, rather than controlled laboratory situations," explained Dr. Lance Wallace, an EPA environmental scientist. "This will allow us to improve on our previous estimates, which were based on mathematical models. We are also introducing new sensitive instruments and methods for this on-the-spot research."

Supporting the research study are the California Department of Health Services and the California Air Resources Board.

EPA officials have been interviewing individuals in about 600 households in the San Francisco area to create a sample from which 75 people will be selected to use the monitors.

Persons interviewed are provided with a letter from EPA Administrator William D. Ruckelshaus asking their cooperation in carrying out the study.

The study is innovative in that it calls for extensive use of personal air quality monitors to measure the extent to which these residents are exposed to concentrations of volatile organic compounds, such as chloroform, benzene, and twenty other organics, during their normal routine. In addition to these portable monitors, fixed-site monitors will be stationed at various locations throughout the study area.

Samples of drinking water will be analyzed, along with breath samples. All of the data will be compared to results of similar studies conducted last year in Greensboro, North Carolina, and Bayonne and Elizabeth, New Jersey, to compare communities of differing populations and industrial activity.

The overall study, which is being carried out by the Research Triangle Institute in North Carolina, measures people's exposure to chemicals, but does not assess health effects.

Early findings are that many of the 20 chemicals studied are present in the air and water of a majority of residents of Greensboro, Bayonne and Elizabeth. In particular, personal exposures to 11 of the most prevalent chemicals are greater — sometimes much greater — than the corresponding outdoor concentrations in the participants' back yards. All 11 of these prevalent chemicals were found in the exhaled breath of the participants, even while breathing pure air, indicating that the chemicals were in their bloodstream. Concentrations in exhaled breath were also often higher than outdoor levels. If confirmed by the California results, these findings would have an impact on EPA's policy toward managing toxic organics in air.

TEAM represents the first use of a statistically sampled population to unravel the relationship between exposure and body burden, according to an article in RTI's publication, *The Hypotenuse*. The term "body burden" refers to the amount of a specific chemical in a person's body fluids and tissues.

Another unique aspect of the TEAM study is that techniques developed at RTI using miniature personal air monitors

played an important role in the field studies. The monitors are capable of collecting and concentrating organic substances in the air continuously for 12 hours. The environmental concentrations of a number of compounds, including chloroform, toluene and benzene, can be determined later in the laboratory by analyzing the contents of the monitor's removable cartridge.Organic volatiles can be determined in the parts per billion range.

"An ultimate goal of TEAM is to develop a model that can predict the frequency of exposure in a popluation and the body burden that results from a given exposure to a certain organic compound," said Dr. Edo Pellizzari, who heads the multidisciplinary team of RTI analytical chemists, survey specialists and statisticians who are carrying out the EPA study.

Workers in many occupations are routinely exposed to a variety of potentially hazardous chemicals, but little is known about how much their bodies actually retain.

For each of the chemicals under study, the RTI researchers also want to find out how the route of exposure affects body burden. For example, it may be that a certain chemical is not absorbed by the body when present in drinking water, but is absorbed when present in air. In addition, some chemicals may be taken up by the body more readily than others.

"Exposure measurements indicate only the potential dosage an individual might receive," Dr. Pellizzari said, "but

Demonstration by Douglas Keeler, a former Research Triangle Institute employee, of special carrying vest and personal air monitoring equipment used in project to measure human exposure to toxics.

exposure is not synonymous with dosage."

Using a properly designed approach, body burden can be a good measure of dosage.So by defining the link between exposure and body burden, the TEAM study will help scientists determine which chemicals pose the greatest risk to the public. Once researchers know the levels of substances absorbed by body fluids and tissue, they will be able to concentrate on the more significant ones.

TEAM, however, will not evaluate the health effects of exposure to various chemicals.

"The next step would be to determine the relationship between body burden, or dosage, of a specific chemical and its effect on one's health," Dr. Pellizzari said. "But determining that relationship is not within the realm of the TEAM."

Health effects laboratories at EPA are investigating the effects of some of these chemicals on animals and conducting bioassay tests which will help estimate the health effect on humans. ☐

Analytical Tools and Techniques

The personal air monitor, which is used to sample air within the breathing zone of study participants, was specially designed for the TEAM study. Weighing only about a pound, the monitor has a battery powered pump. It is preset and requires no adjustment by the wearer. During the 24-hour monitoring period, the cartridge needs to be changed only once. Identical cartridges are used in the personal air and fixed site monitors.

Before they could conduct a large-scale study of human exposures and body burden, RTI researchers had to develop an accurate and reproducible methodology for measuring low levels of volatile organic pollutants in air, breath and water.

To collect the first two types of samples, air and breath are pumped across a cartridge containing a polymeric sorbent called TENAX, which traps certain organic chemicals present in the sampled air. After they are returned to RTI for analysis, the cartridges are heated in a special chamber. The organic compounds are then thermally purged from the cartridge with helium gas and collected in a liquid nitrogen-cooled trap. Next the collected vapors are separated by gas chromatography and analyzed by electron impact mass spectrometry.

Dr. Edo Pellizzari, TEAM principal investigator, began developing the procedure for using TENAX to measure the concentrations of organic chemicals in ambient air several years ago. However, the TEAM study marks the first time this technique has been adapted to a miniature personal monitor and field tested on a very large number of people.

A special spirometer was also developed by RTI researchers for the TEAM study. Used in the field to collect breath samples, it consists of two bags. One contains pure, humidified air, which a study participant breathes while wearing nose plugs. Exhaled breath is collected in the other bag.

"It takes from three to five minutes of breathing for a person to fill the empty bag," explained RTI chemist Jeff Keever. "It contains about 40 liters of air when full." After the bag is filled, the air in it is pumped through a TENAX cartridge to trap exhaled volatile organic compounds. These cartridges are returned to RTI, where they are analyzed in the same way as those from the personal air and fixed site monitors.

Unlike the air and breath samples, the pollutants in drinking water samples are not extracted in the field. Vials of collected drinking water are kept tightly sealed and refrigerated until they arrive at RTI. In the laboratory, organic compounds are purged from the water samples with helium and pumped across a TENAX cartridge. The flow of gas is then reversed, and the trapped pollutants are removed from the cartridge and introduced into a gas chromatograph/mass spectrometer for analysis.

Extensive quality control and quality assurance activities have been employed in this experimental study. EPA's Environmental Monitoring Systems Laboratory at Research Triangle Park has conducted continuing audits on all phases of the study. All types of samples are analyzed in duplicate by a separate laboratory. ☐

Reports from EPA's Laboratories

EPA's Office of Research and Development administers 14 laboratories around the country, from Las Vegas, Nev., to Narragansett, R. I. To learn about the research activities and priorities at these laboratories, EPA Journal asked for reports highlighting their work. Here are summaries by these facilities.

Environmental Research Laboratory Athens, Ga.

Research at the Environmental Research Laboratory in Athens, Ga., predicts what happens to chemicals that are discharged or introduced into lakes and rivers from point and nonpoint sources.

In cooperation with EPA's Office of Water, the Athens laboratory is examining samples of wastewater from industries across the United States to identify organic compounds that are being introduced into the environment in potentially toxic amounts. Identification, at concentrations as low as 10 parts per billion, is achieved through the use of sophisticated computer programs/mass spectrometer systems developed at the laboratory. This cooperative survey will help provide a profile of chemical compounds for each industry.

A mathematical model of pesticide behavior is being used to estimate the amount of TEMIK, an insecticide that has been found in wells in Florida, in leachate from agricultural areas, to predict the insecticide's movement and fate in ground water, and to estimate concentrations in wells or withdrawal points. The Pesticide Root Zone Model also is being applied in a long-term field study in South Georgia to determine the movement of aldicarb, the active ingredient of TEMIK, and other soil-applied agricultural chemicals into ground water.

Assistance to water quality managers in EPA and in state and local governments in the use of mathematical models in analyzing problems and evaluating the effects of controls on different sources of pollutants in watersheds is provided through the laboratory's Center for Water Quality Modeling. The Center distributes and maintains computer programs and documentation and sponsors workshops that provide generalized training in the use of models and specific instruction in the application of individual simulation techniques.

Environmental Research Laboratory Gulf Breeze, Fla.

EPA's Gulf Coast research laboratory, located in Gulf Breeze, Fla., investigates the effects of toxic chemicals on coastal, estuarine, and marine environments and evaluates the response of species of the habitats to environmental stress.

Priorities for 1984 research are:

- Biological control agent safety testing: to develop methods and standards to assess hazards to aquatic species from biological pest control agents that affect insect survival, growth, development, reproduction, and behavior.
- Drilling fluids: to determine chemical characterizations and effects of fluids used in oil exploration and drilling to assess possible sublethal, long- term impacts on marine life.
- Field validation: to evaluate existing laboratory procedures for hazard assessments of pollutants by comparing laboratory test results with observations following field applications of pesticides in ongoing mosquito control programs and other applications of toxic materials to the environment.
- Chemical biodegradation: to develop laboratory systems that can predict the rate at which complex pollutants will detoxify naturally in the environment.

Major research work completed in FY 1983 included a report on toxicity tests, chemical characterizations, and modeling with drilling fluids conducted primarily under grants or contracts with universities and private laboratories, and a study of the use of aquatic systems and organisms in monitoring pollutants for cancer risks.

Research toxicologist Lee Courtney (left) and research biologist Steve Foss of the Environmental Research Laboratory in Gulf Breeze, Fla., examine a fish for tumors.

Health Effects Research Laboratory Research Triangle Park, N.C.

The Health Effects Research Laboratory at Research Triangle Park has five priorities for the coming year. They are:

• Clinical research: The laboratory's clinical research program is conducting a research project to measure the effects of carbon monoxide exposure on the hearts of volunteers with coronary artery disease. This research, using a gamma camera, is designed to determine if individuals who have coronary vascular disease are at greater risk than the general public when they inhale low concentrations of carbon monoxide.

• Genetic bioassay research: Bioassay testing of photochemical reaction products of diesel, wood and peat emissions is used to determine mutagenic activity. This research involves outdoor reaction chambers coupled with biological testing chambers.

• Animal toxicology studies of ozone and nitrogen dioxide: The laboratory's toxicology branch is conducting a major study to investigate the chronic effects on animals of exposure to ozone and nitrogen dioxide. Inhalation studies with rats exposed to these pollutants for up to 18 months are performed to characterize pulmonary effects and effects on the immune system.

• Developmental biology research: The developmental biology division of the laboratory is performing research to determine age-related effects of environmental pollutants. New research is underway involving the use of *in-vitro* cultured rat and hamster embryos to determine species differences in teratogenic response.

• Radiofrequency radiation health effects research: The experimental biology division is carrying out research to determine the effects of radiofrequency radiation on brain structure, function and processes.

The Toxicology and Microbiology Division of the Health Effects Research Laboratory, located in Cincinnati, has primary responsibility for health research in the EPA water programs. The division has a staff of toxicologists, biochemists, physiologists, analytical chemists, microbiologists, and epidemiologists with broad capabilities for investigating both chemical and microbiological hazards that may be associated with drinking water, wastewater and sludge.

Contamination of drinking water can arise in three basic ways—pollution of the source, pollution from by-products of treatment, and leaching from the pipes in the distribution system. The most consistent contamination occurring in drinking water arises from the treatment and distribution of water for public consumption. For example, disinfection of drinking water gives rise to a variety of by-products whose toxic properties have yet to be defined, in addition to the now regulated *trihalomethanes*.

Additionally, there is reason to suspect that similar by-products are formed in the gastrointestinal tract when drinking water containing residual disinfectant is consumed. There is evidence that chemicals capable of producing toxic responses in the reproductive and cardiovascular systems result from reactions of chlorine to produce carcinogenic and mutagenic chemicals.

Unfortunately, similar problems have been encountered with other disinfectants and more research is needed to identify and quantify the potential hazards.

Physical scientist Pat Clark using electron microscope to perform analysis at EPA's Health Effects Research Laboratory in Cincinnati.

The implications for changes in water treatment practices that these observations raise also point to the need to reevaluate the potential impact of established and newly-recognized waterborne, pathogenic organisms. Consequently, research focused on developing appropriate methodologies for detecting the causative agents associated with waterborne outbreaks is also an integral part of the Toxicology and Microbiology Division's research program.

Health research in the municipal wastewater area focuses primarily on questions related to the utilization and disposal of municipal wastewater sludge. Two critical areas exist that have not been addressed by previous research. The first is the indication that certain sludges contain high levels of mutagenic chemicals that cannot be accounted for by analysis for known constituents of sludge (e.g., the priority pollutants).

The second area is developing the data necessary for assessing health risks for each use or disposal method for sludge. Data relative to distribution, marketing and composting operations are particular problems with regard to chemical and microbiological contamination respectively. However, the most critical issue is to demonstrate how such information can be used to make overall estimates of the risks associated with the particular use of a specific sludge without having to take a contaminant-by-contaminant approach to the problem.

In the chemical area, the laboratory intends to demonstrate how bioassay information may be used in the decision process, whereas developing an indicator system and or adopting most critical pathogen approaches are being explored in the microbiological area.

The water quality research program responds in large part to the NPDES Permitting Program. This process is the one mechanism by which the agency is able to protect water quality on a local basis.

For the future, emphasis is being placed upon developing the decision logic for, and application of, biological testing methods to improve the ability of the permitting process to prevent hazards arising from poorly characterized effluents. Research in the microbiological area focuses on developing disease-related water quality indicators for shellfish-growing waters.

Environmental Research Laboratory Corvallis, Ore.

The highest priority research at Corvallis is focused on determining the effects of acid rain on aquatic and terrestrial resources. This laboratory chairs the federal interagency work group on aquatic effects and is a major participant in the group documenting terrestrial effects. The main objectives of the aquatic research are to determine:

- Susceptibility of the nation's waters to acid rain
- Current extent of effects
- How acidified waters affect biological processes
- Methods to predict changes
- Human health implications
- Effective mitigative measures

The objectives of the terrestrial research are to determine the effects of acid deposition on:

- Agricultural crops
- Watersheds and outputs to aquatic systems
- Soils and soil processes
- Forest productivity

Other programs at Corvallis include the National Crop Loss Assessment Network (NCLAN) which seeks to establish a dollar cost to consumers from loss in agricultural productivity as a result of air pollution, primarily from the impacts of ozone. Scientists in the plant toxicology program are developing methods to measure and evaluate the effects of toxic materials on plants and the potential for penetrating the human food chain.

Animal toxicology is a comparatively new research area for this laboratory and for EPA. Current projects are evaluating test methods used by EPA to determine the lethality of chemicals to wildlife. Test animals are bob white quail and mallard duck. As the program grows, the physiological impact of toxics to these and other mammals will be studied to help the agency assess chemical hazards.

In the hazardous waste area, cost effective techniques are being developed to assess the degree of hazard at locations receiving hazardous wastes. Soils from land sites and sediments from receiving waters are being studied to determine what criteria are needed to protect human and aquatic life.

Other aquatic research is focused on two priorities: (1) methods to identify aquatic eco-regions based on mapped land features, correlating those regions with aquatic characteristics to simplify determination of attainable uses, and (2) development of improved criteria for dissolved oxygen.

Municipal Environmental Research Laboratory Cincinnati, Ohio

Research concerns at the Municipal Environmental Research Laboratory range from wastewater sewage to oil releases. Here are some examples of the work now underway:

Securing Drums

Corroding 208-liter (55-gallon) steel drums holding hazardous wastes present a threat to man and the environment, a threat that is intensified in uncontrolled disposal sites. To prepare such drums for secure and safe transportation and disposal, a process was developed to encapsulate them in polyethylene overpacks. Process features are custom designed polyethylene overpacks and a friction welding apparatus to produce seamless overpack seals.

Crop Uptake

Beginning in the 1970s, EPA researchers started determining the types and concentrations of organic compounds in sewage sludge. This effort has been expanded to include the fate of organic compounds in sludge treatment systems. The results of these studies have posed questions about the environmental fate of the organic compounds when sludge is applied to soil.

A workshop was held on the "Use of Municipal Wastewater and Sludge on Land" in February 1983, summarizing 10 years of research on the subject. The proceedings of the workshop have been published.

Fuel Savings

The Municipal Environmental Research Laboratory entered into a demonstration agreement with Indianapolis, Ind., to determine if the fuel requirements for sewage sludge incineration could be reduced.

About $1,000,000 a year in fuel costs are saved by the city as a result of the demonstration. Another $3,000,000 one time savings were realized when Indianapolis was able to cancel plans for construction of new air pollution control equipment because the demonstration brought the incinerators into compliance with air pollution regulations. All this was accomplished by installing $250,000 worth of instrumentation and equipment and greatly improving the incinerators' operating methods by what is now known as the "fuel-efficient mode of operation." The fuel-efficient mode is essentially a partnership of sound engineering and good operation. Other cities, among them Nashville, Hartford and Buffalo, have saved fuel because of improved instrumentation and fuel efficient operation.

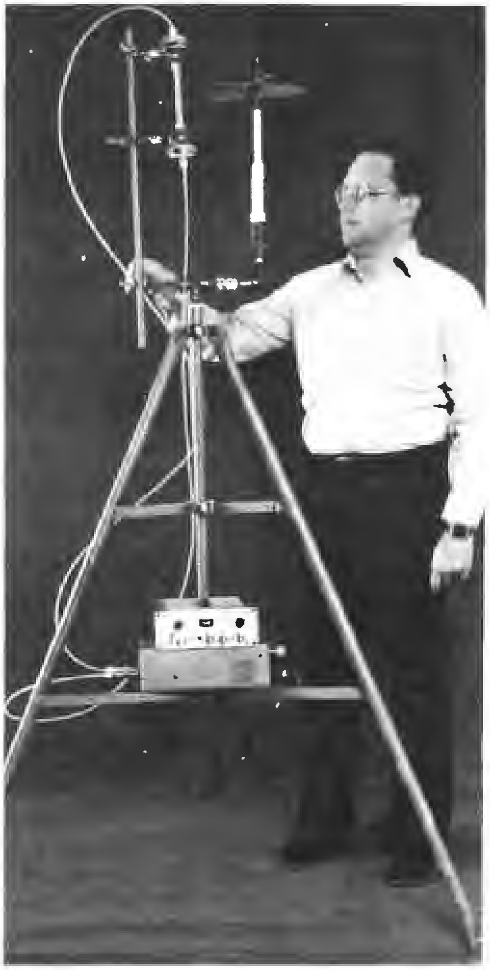
Drinking Water Treatment

The principal goal of this research area is to establish practical, cost-effective but theoretically sound technologies capable of removing known and potentially toxic constituents found in drinking water. A current high priority area of investigation is the problem of contamination of ground water by synthetic organic chemicals. Techniques being examined for their efficiency and cost effectiveness in removing organic contaminants are air stripping, granular activated carbon, special resins, and home treatment devices.

Alternative Technology

The Clean Water Act encourages the development and implementation of "Innovative and Alternative" (I/A) technologies and improved management and operation of wastewater and sludge collection, treatment and disposal systems. Technical reviews by the laboratory of more than 200 proposed I/A technology projects have served as the basis for state/regional funding decisions, and have avoided the construction of technology which probably would have failed. The payback for this activity has been estimated at 27 to 1, for a total cost savings of about $12.5 million.

Environmental Sciences Research Laboratory Research Triangle Park, N.C.



The Eddy Accumulator, an instrument developed by the Environmental Sciences Research Laboratory in Research Triangle Park, N.C., to measure the dry deposition rates of acidic pollutants. With the instrument is a laboratory scientist, Ronald E. Speer.

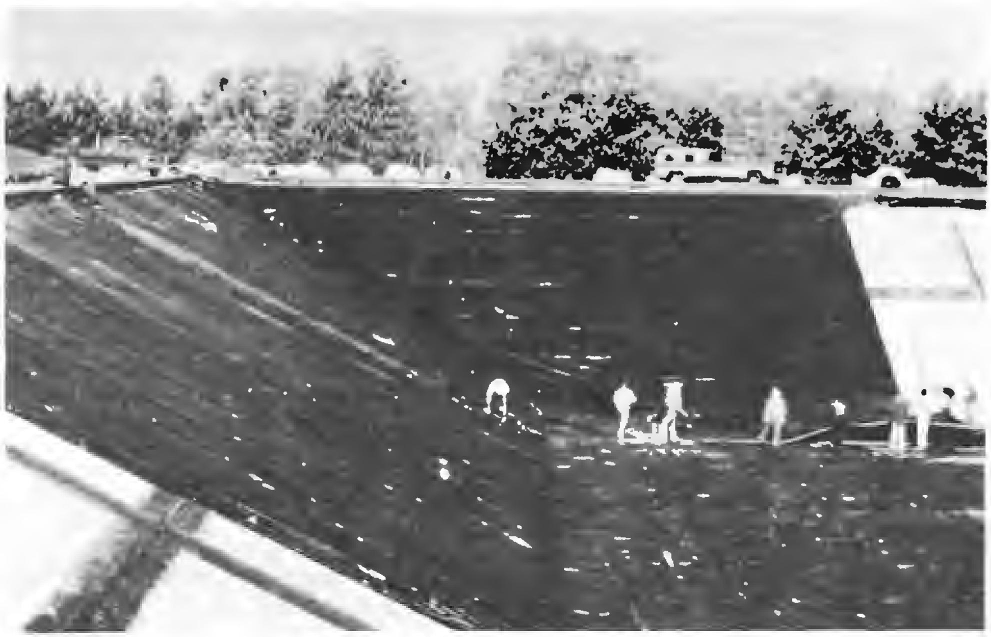
The Environmental Sciences Research Laboratory at Research Triangle Park conducts a research program in the physical sciences to detect, define, and quantify air pollution and its effects over various space and time scales. This laboratory is composed of divisions dealing with emissions, chemistry, and meteorology; major projects involve expertise in all three areas.

The highest priority program at the laboratory during the next year involves investigations into the causes of acid deposition, the transfer of airborne acidic pollutants to the earth's surface by dry or wet acid rain processes. The program blends laboratory, theoretical, and field research in a unified, multidisciplinary approach. Major components deal with numerical modeling, chemical composition of precipitation, flow patterns in the atmosphere, chemical transformations of pollutants, dry deposition rates, and damage to man-made materials. Analysis and modeling of acid deposition for mesoscale (300 kilometer) distances will be a prime consideration, and active planning will be proceeding for a comprehensive regional scale (2,000 kilometer) field study in conjunction with other federal and industry research groups.

Research will continue on ozone formation caused by sunlight-induced reactions involving hydrocarbons and nitrogen oxides derived from automotive, industrial, and natural sources. Reaction rates will be investigated using controlled pollutant mixtures in laboratory smog chambers. In anticipation of alternate fuel usage, combustion products of methanol will be included this year. Sets of equations describing the scores of reactions thought to take place in the atmosphere will be further developed and tested. Finally, the chemical information will be integrated into models that simulate all atmospheric processes on urban to regional scales.

Work on hazardous and toxic air pollutants will describe chemical reactions, lifetimes, and transformation products using laboratory techniques. Methods of predicting reaction mechanisms for untested compounds will be based on similarity of molecular structures. Measurements of aerosol and gas phase transformation products will describe urban atmospheres, and the data base will be expanded on hazardous organic chemicals and their ambient concentrations.

A field study at the Tracy Power Plant in Nevada will supply validation data for numerical models of dispersion of plumes from large pollutant sources in the mountainous western U.S. Allied to such field efforts are investigations of terrain effects on pollutant dispersion using the laboratory's wind tunnels and water channel. These laboratory methods provide carefully controlled experiments with rapid turnaround, and research officials expect to use the facility to provide data for a court-ordered reconsideration of stack height regulations.



Synthetic liner being installed at hazardous waste dump site to protect against leaching. Liner was developed by the Municipal Environmental Research Laboratory in Cincinnati.

Environmental Monitoring Systems Laboratory Research Triangle Park, N.C.

The Environmental Monitoring Systems Laboratory at Research Triangle Park has the lead responsibility for the agency in methods development related to air sampling and is the agency program manager for air quality assurance activities. Major emphasis is now being given to newer and more accurate methods for sampling (e.g., new sorbents, cryogenic trapping) and analyzing toxic air pollutants (e.g., luminescence, supercritical fluid). Development of new active and passive monitors to measure indoor and/or total exposure to pollution is also being pursued.

The laboratory is addressing all aspects of air quality assurance. The air national audit program supplies audit materials for many ambient air pollutants, source pollutants, and acid rain. Special on-site audits are conducted for major EPA monitoring programs. All EPA air monitoring projects are required to have approved quality assurance programs. The Quality Assurance Division of the laboratory operates the equivalency program for ambient air monitors. This group also is providing major input into the regulation establishing a new particulate standard.

Congress funded EPA to address the problem of indoor air quality in 1984. The Environmental Monitoring Systems Laboratory at RTP has been named the lead laboratory for this effort. In addition, EPA chairs an Interagency Committee on Indoor Air Quality. For the first time the federal government will have a coordinated program for investigation of indoor air quality. Current efforts focus on development and validation of a protocol to conduct large field studies to characterize the extent and severity of indoor air pollution. This information along with results from source characterization studies, radon mitigation studies, and health indicator studies will be combined to form the EPA input into the national health and nutritional study (NHANES III) scheduled for 1987.

Because of its experience in air monitoring, the laboratory has been given the lead in researching, developing, and deploying an acid rain dry deposition network. A pilot study will begin in FY-84 and continue into FY-85. A major network of 100 stations is scheduled for FY-86. A methods development/evaluation of dry deposition monitors has also begun in support of the dry network. The laboratory is also actively participating in NADP/NTN - the wet deposition network. The laboratory has taken the lead in developing a quality assurance program for the network.

Industrial Environmental Research Laboratory Research Triangle Park, N.C.

EPA's particulate program in the Office of Research and Development performs research responsive to the needs of the program offices, regions, states, and user community and helps ensure that technology necessary to achieve ambient particulate levels consistent with the health-based ambient air quality standards is available. It is active in a broad range of activities aimed at providing cost-effective technology for control of particulate emissions from smokestacks as well as for fugitive particulate emissions. The program which is centered around the in-house facilities at the EPA Industrial Environmental Research Laboratory in Research Triangle Park has one of the better equipped particulate control laboratories in the world. The laboratory contains a number of electrostatic precipitator and fabric filtration pilot units. Extramural research supports and augments the in-house work.

Acid rain and the proposed inhalable particulate standard will impact upon the program and its direction. Most acid rain mitigation options and the control of finer particles will make more stringent demands upon particulate control which may consequently require costly upgrading.

The Industrial Environmental Research Laboratory for the past 15 years has carried forward a combustion research program aimed at developing and evaluating cost-effective combustion process modifications for controlling nitrogen oxide emissions from stationary sources. The information gained is used (1) to support EPA's Office of Air Quality Planning and Standards in its development of standards and (2) for technical assistance to EPA regional offices and states.

Over these years the combustion research staff has gained a high level of expertise in understanding the complex fundamental phenomena associated with combustion processes as well as wide experience in the practical application and performance testing of the control technologies on a variety of field operating combustion systems. More recently, this combustion expertise has been directed at providing fundamental hazardous waste incineration input in support of the hazardous waste program at the Industrial Environmental Research Laboratory in Cincinnati in addition to the primary emphasis on the nitrogen oxide control program.

The major efforts of the nitrogen oxide (NOx) control program during the next year are focused on the application and assessment of several advanced control technologies. One is the evaluation of an advanced low NOx heavy oil burner for industrial boilers and for the incineration of highly nitrated wastes. A second advanced technology, based on the in-furnace reduction of NOx through the injection of secondary fuel beyond the primary combustion zone, is capable of lowering NOx emissions by at least 50 percent from the levels entering this secondary combustion zone.

In support of the hazardous waste incineration programs, studies are directed at fundamental research to develop a better understanding of solid or sludge incineration processes so that failure modes of various incinerator designs (e.g., fluidized bed, rotary kiln or fixed hearth) can be identified and eliminated.

The LIMB program is an effort of the Industrial Environmental Research Laboratory to develop effective and inexpensive emission control technology for coal-fired boilers that will reduce sulphur and nitrogen oxides. (LIMB stands for Limestone Injection Multistage Burner.) LIMB technology represents a low-cost alternative to currently available SOx control approaches; e.g., flue gas desulfurization, coal cleaning, and coal switching. LIMB technology is attractive if coal combustion must be controlled to minimize emissions of acid rain precursors because LIMB is easily retrofitted to large and small coal-fired boilers, is lower in cost than any available alternative, and can control both $SO_x$and NO_x— the two major acid rain precursors.

Environmental Research Laboratory Narragansett, R. I.

Over half of the U.S. population lives in a 50-mile wide strip of land along the nation's coasts. Unregulated ocean-waste disposal has led in the past, and will lead in the future, to adverse impacts on human health and the environment. EPA has the legislative responsibility to regulate the safe disposal of wastes in the ocean. The Environmental Research Laboratory at Narragansett, R. I. and its field station at Newport, Ore., is the agency's center for research related to the development and evaluation of procedures to assess environmental impacts due to ocean disposal of wastes.

The laboratory has adapted a hazard assessment strategy to evaluate the environmental risk posed by ocean disposal of wastes. Research is being conducted on five components (i.e., site characterization, waste characterization, exposure assessment, effects assessment and monitoring) of a dredge material disposal operation in Long Island Sound. Disposal site characterization was conducted by the Corps of Engineers. The waste was characterized using physical, chemical and biological tests including short- term screening tests with the solid phase and/or the suspended particulate phase of the waste.

Exposure studies in the field are quantifying the relationship between source inputs of waste contaminants and concentration distributions of these contaminants in space and time. Effects studies both in the laboratory and the field are being conducted to verify a hierarchy of biological tests which predict the environmental consequences of ocean disposal. Dumpsite monitoring is providing data for field validation of hazard assessment predictions as well as developing methods for monitoring disposal operations in the future.

Environmental Research Laboratory Duluth, Minn.

The Environmental Research Laboratory in Duluth, in cooperation with the Criteria and Standards Division of the EPA Office of Water, has recently developed national and site-specific guidelines for deriving water quality criteria using laboratory procedures. Relatively few studies have been undertaken to determine whether water quality criteria derived from laboratory data provide protection to natural ecosystems. Field studies have been conducted at the Monticello, Minn., Ecological Research Station to determine the appropriateness of proposed water quality criteria in protecting ecosystems and in formulating guidance on defining the meaning of ecosystem protection.

The Monticello station is a field facility of the Environmental Research Laboratory-Duluth. The station is located 45 miles northwest of Minneapolis, Minn., adjacent to the Northern States Power Co. nuclear power plant and the Mississippi River. The station has eight outdoor experimental channels. Each one is 1,700 feet long and 0.3 acres in water surface area, and contains nine mud-bottom pools alternating with eight 100-foot-long gravel riffles. Experimental test water is pumped directly from the Mississippi River and/or wells to the outdoor channels. Invertebrate and plant populations are naturally colonized; fish are stocked each year.

The experimental approach has focused on measuring fate and effects of toxicants under both continuous and intermittent exposures. Selection of the exposure concentrations is based on proposed or published water quality criteria and onsite laboratory bioassay results. Ecosystem protection is determined by evaluating both structural and functional biological responses. Structural responses include diversity and biomass changes, and also incorporate survival, growth, and reproductive measures. Functional responses address energy flow (production/respiration ratios, litter decomposition, carbon cycling) through the outdoor test system. Toxicant fate is evaluated with available models to elucidate pollutant behavior in aquatic systems.

Field studies have been conducted with six chemicals (acidification- sulfuric acid, para-cresol, Diazinon, Dursban, pentachlorophenol, and ammonia) and one physical pollutant (temperature). Site-specific evaluation studies thus far have shown that reasonably good ecosystem protection has been provided from exposures near the derived criteria limits. Tests in 1983-1984 with pentachlorophenol and ammonia indicate that these criteria were reasonably satisfactory for ecosystem protection. Additional criteria evaluations are required if EPA and the states are to gain confidence in water quality criteria derivation protocols.

The Environmental Research Laboratory at Duluth, Minn., has set up eight outdoor channels (lower center and right) as an experimental approach to measure the fate and effects of toxic substances in water. The channels are at the laboratory's Monticello station on the Mississippi River next to a Northern States Power Company electric power plant.

Environmental Monitoring and Support Laboratory Cincinnati, Ohio

Dan Dahling of the Environmental Monitoring Systems Laboratory in Cincinnati working with tissue culture stocks that will be used to prepare assay bottles for detection of waterborne viruses. Dahling is with the virology staff.

The Environmental Monitoring and Support Laboratory in Cincinnati evaluates and standardizes methods to analyze the presence and concentration of physical, chemical, and radiological pollutants in water, wastewater, sediments and solid waste; investigates methods for concentrating, recovering, and identifying viruses and microbiological organisms in water; and conducts an agency-wide quality assurance program for standardizing and assuring quality control in water and wastewater monitoring systems. Methods research and quality assurance activities are major programs which involve all laboratory personnel in one aspect or another in a continuing effort to provide state and local laboratories with the necessary tools to implement the agency's monitoring program.

Methods Research: Current high priority research in the Physical and Chemical Methods Branch is dedicated to developing cost-effective methods for a large variety of potentially hazardous and toxic chemicals which cannot be measured by existing gas chromatography techniques. A major breakthrough appears close at hand with the development of thermospray mass spectrometry.

Monitoring technology for waterborne viruses has been in the making for several years. A manual of virology methods, soon to be published, will provide the scientific community with methods for recovering, detecting, identifying, and confirming viruses from most environmental samples except air. The manual will constitute the agency's official methods for environmental virus monitoring.

Quality Assurance: The Quality Assurance Branch will be conducting major performance evaluation studies for approving and/or certifying over 8,000 drinking water, water pollution, water quality, and major discharger laboratories under the National Pollutant Discharge Elimination System. The Quality Control Sample Program and the EPA Repository for Toxic and Hazardous Materials will be expanded to cover the hazardous and toxic waste programs and the revised drinking water regulations as well as all parameters covered under the present water laws.

Robert S. Kerr Environmental Research Laboratory Ada, Okla.

The Kerr Environmental Research Laboratory is directly involved in research on two of the highest priority agency activities: ground-water protection and land treatment of hazardous wastes.

Since most of the present ground-water contamination incidents are directly related to improper storage or disposal of hazardous wastes, the inclusion of both of these programs under the same laboratory management is a beneficial symbiotic relationship unequalled elsewhere in the organization.

The laboratory's mission to investigate the subsurface environment includes research to:

- Determine the fate, transport, and transformation of pollutants in the soil, the unsaturated zone, and the saturated zone;
- Define the processes used to characterize the soil and subsurface environment as a receptor of pollutants;
- Develop techniques for predicting the effects of pollutants in soil, ground water, and on indigenous organisms; and
- Define and demonstrate the applicability of using natural processes for protection of the resource.

Utilization of the natural processes of soil medium in a scientifically controlled manner to detoxify and degrade hazardous wastes is based on phenomena as old as nature itself. The research necessary to define the limitations of waste application, incorporation, and management of the soil system is inextricably interlaced with the research necessary to protect ground water because the soil, the unsaturated zone, and saturated zone are sequentially contiguous.

The laboratory staff includes personnel experienced not only in agricultural, municipal and industrial waste treatment, and ground-water protection, but also those who constitute the nucleus of EPA's expertise in those areas—a truly multidisciplinary group including people with engineering, biology, geology, hydrology, chemistry, microbiology, and soil science specialties.

Industrial Environmental Research Laboratory Cincinnati, Ohio

One of the highest priority objectives of this laboratory's research is to determine ways to reduce and control environmental waste problems. The goals of these programs are to establish a basis for public acceptance of disposal options. To do this, research efforts will provide the technical information necessary to assure reliability of control technologies or methods.

The waste disposal research is focused on two areas. The thermal destruction program is directed toward supporting the EPA Office of Solid Waste in the development of regulations and the regional offices' permitting and compliance programs. An example of current research activities is defining operating conditions for incinerators to insure complete destruction of hazardous wastes.

The second area is the chemical detoxification program. This program addresses the problems of dioxin-contaminated soils, i.e., the serious dioxin problem in Missouri. The laboratory's efforts are geared to solving these problems without removing the soil, an approach which is much less costly than others which require the movement of huge amounts of soil.

A recent important development for the laboratory is the opening of its Combustion Research Facility in Pine Bluff, Ark., and the Center Hill Facility in Cincinnati, Ohio, where the laboratory is conducting its in-house research. These are unique, specially designed facilities to support the agency's hazardous waste thermal destruction research programs.

Environmental Monitoring Systems Laboratory Las Vegas, Nev.

Three of the Las Vegas laboratory's priorities during the next year are as follows:

- The application of surface and down-hole geophysical methods such as electromagnetic induction and resistivity techniques holds considerable promise for rapidly assessing subsurface contamination problems and for targeting the locations of ground-water monitoring wells. The laboratory is evaluating the capabilities of commercially available equipment and developing field application and quality assurance procedures to help in proper interpretation of data that are obtained. A number of collaborative projects with the EPA regional offices will be carried out as an integral part of the agency's assessment activities at Superfund sites.

- The laboratory is developing methods that should improve the agency's capability to analyze complex samples faster, at lower costs, and with greater confidence in the analytical results. A tandem mass spectrometry system is being used for analyzing complex dyes, and a quality assurance program is being implemented to support high-resolution analysis of dioxins in environmental samples. A Fourier Transform Infrared system is being merged with a Gas Chromotography Mass Spectrometry system to enable concurrent confirmatory analyses for chemicals which are particularly difficult to measure. During the next year protocols for these types of analyses will be evaluated and made available to commercial laboratories which support agency programs.

- Geostatistics is based on spatial correlations among sampling points within a contamination plume. The technique was successfully applied in designing the soil sampling program for determining the extent of soil contamination around lead smelters in Dallas. The technique is now being investigated for application to other types of soil pollution problems such as dioxin contamination. □

Dr. Leon D. Betowski, researcher at the Environmental Monitoring Systems Laboratory in Las Vegas, operates a Triple Stage Quadrupole Mass Spectrometry System with the capability to analyze dyes and other complex mixtures.

EPA Probing Forest Damage

Camel's Hump, a peak in the Green Mountains of Vermont where research supported by EPA and others has revealed a die-back of red spruce trees, a deterioration similar to that being found in some other high elevations in the eastern U.S.

A major research effort is being launched by EPA and other Government agencies to help determine the causes of a significant decline in the diameter growth of at least five species of trees in the Eastern United States.

This project was discussed by William D. Ruckelshaus, EPA Administrator, in recent testimony on air pollution problems before a Congressional subcommittee.

"Based on a limited amount of data, it appears that over a wide area of the Eastern United States, there has been a pronounced decline in tree diameter growth of several species of trees over the past two decades," Ruckelshaus said. "This lack of growth is not correlated with any specific climatic trend, and because it involves a number of species over such a wide geographical range, it does not appear to be solely attributable to normal ecological processes.

"In high altitudes, a more severe set of symptoms called die-back has been observed. We have seen significant losses in at least five species of trees.

"In Europe, different and more extensive types of tree damage have been observed, involving at least ten species.

"We do not know the true extent or meaning of this damage, the speed at which it is taking place, or what factor or combination of factors is causing it. We do not know if the causes are the same in Europe as in this country. Many investigators believe that several interconnected factors are at work, and that air pollution of some sort may be important among them. Our current knowledge, however, does not tell us whether the offending pollutants are sulfates, nitrates, oxidants, or heavy metals. This new information, while troubling, raises the possibility that if we act too quickly, we may control the wrong pollutant.

"This situation illustrates well why waiting for further research to be completed before initiating a control program is a rational decision. If, as many believe, sulfate deposition is not a major contributor to forest problems but oxidants or nitrates are, a significant reduction in SO_2 emissions could inadvertantly result in elevated levels of oxidants or nitrates. Our current understanding of atmospheric chemistry indicates that if we were to reduce SO_2, it might result in increased levels of oxidants. Additionally, excess oxidants could then combine with the NO_x to produce more nitrates. Thus, in either case controlling the wrong pollutant could conceivably make matters worse.

"The interagency research program expands the work on forests. A long-term terrestrial survey is being designed and should be ready to be carried out in about a year. EPA is sponsoring joint meetings and field observations by European and American scientists both here and in Europe to identify the major hypotheses which could explain the mechanisms of forest damage. Once these hypotheses are identified, research efforts can be launched to test them either in the field or in the laboratory in order to identify the proper cause and effect mechanisms."

Turning to the subject of recent testimony that acid rain causes health damage, Ruckelshaus told the Subcommittee on Health and the Environment of the House Committee on Energy and Commerce: "We agree with the recent National Institute of Environmental Health Sciences report on this subject which, though cautious, did not find any basis for immediate alarm. Nevertheless, as the Institute suggests, further assessment is warranted to expand our understanding of such potential effects as the leaching of heavy metals into drinking water by acid rain, and the impacts of breathing sulfates and acid fog.

"When I testified on acid rain before the Senate Public Works Committee last month I was repeatedly asked when we will know enough to make a decision regarding controls. I am sure that many of you have the same question. The answer is that I do not know, because I cannot predict ahead of time what answers will come out of our research program or when.

"The Interagency Task Force plans to produce formal assessments of the information gained from the acid deposition research program in 1985, 1987, and 1989. These will be important milestones in integrating our understanding of acid rain's causes and its effects.

"However, our assessement of the policy impact of what we are learning from the research program *must* be a continuous process. As we continue to gain knowledge of the deposition problem, our ability to predict the results of various control efforts will increase, and we will reach the point where the Administration can responsibly make a decision regarding the need for additional controls. I cannot tell you exactly when that point will come, for I cannot predict what the answers from the research program will be or when they will be forthcoming.

"What I can tell you is that I take it as an affirmative duty on my part as Administrator of EPA to ensure that we make this active reassessment an ongoing process and that I communicate our newly-found knowledge to the key decision-makers in the Administration, including the President, as soon as appropriate.

"This concludes my summary of acid rain. I recognize that this issue has been and remains a most divisive one between many members of Congress and the Administration. Unlike any other pollution problem, acid rain has the potential for dividing us along regional and international lines. I believe that if we all approach this problem with good will and a recognition of the legitimate concerns of people in every section of this country and Canada, we can solve it. I pledge my best efforts to work with you to do so."

Speaking on regulation of hazardous air pollutants under section 112 of the Clean Air Act, Ruckelshaus said, "it is no secret that EPA has had problems in implementing section 112. While some of these have been the result of management problems which we are working hard to correct, others are the inevitable result of the complex nature of the problem and the scientific uncertainties involved. Given the difficulties we have had in implementing section 112 — difficulties that have extended over many years and several Administrations — it seems reasonable now to take a hard look at the structure of the hazardous air pollution program.

"Section 112 requires EPA to impose numerical emission limits on industrial sources of a specific chemical that EPA has 'listed' on health risk grounds. Cancer is the health risk at issue in virtually all listing decisions.

"Our knowledge about the cancer-causing effects of exposure to various substances at ambient levels is far from perfect. To best protect public health, given this uncertainty, EPA has evaluated the cancer risk of chemicals by making conservative assumptions that yield a plausible upper-bound estimate of the risks at low doses. For example, we assume that the cancer risk of exposure to a chemical does not vanish to zero as the dose declines, but decreases in a linear fashion with the dose level. We also assume that a substance acts as a carcinogen in humans with the same potency that it shows in the most sensitive laboratory animal species. We base our exposure estimates on dispersion modeling, and in some cases we assume that people spend their entire lives out-of-doors breathing ambient levels of these pollutants. Given these assumptions, we are confident that our risk estimates for individual chemicals are probably overestimates of risk. That is, the chances are high that the true risk falls below our estimates. In some cases, that risk could be as low as zero.

"Using these conservative assumptions, we have assessed the cancer risk from emissions of these pollutants from industrial point sources such as chemical and manufacturing plants. In many cases these risk assessments indicate that the health benefits of requiring controls on most industrial source categories are relatively low. Based on our current experience, NESHAP standards that eliminate more than one cancer case per year are more the exception than the rule.

"Such tentative findings are disturbing because they suggest that the current approach to regulating air toxics may not yield much in the way of public health protection. Indeed, our current information suggests that most hazardous air emissions arise not from major industrial sources, but from numerous small sources and from "non-traditional" sources such as waste dumps. In those cases where the culprit is a large industrial source, we often find that there are only a few others like it across the country. We are now engaged in a serious attempt to estimate the public health risks from such sources and to compare these risks with those associated with the major industrial sources traditionally addressed under 112.

"This is not to say that preventing these relatively few cancer cases which may be caused by hazardous air pollutants from industrial sources is not important. Obviously, it is. But we all have a responsibility to use the limited resources of government and society to locate and reduce the most significant risks first. In these cases, it appears that the limited resources used to set NESHAPs may be employed elsewhere to achieve greater public health protection.

"Given what we know about the nature of cancer and the hazardous air pollutant problem, we think the Congress should adjust the Act so as to have its terms confront reality.

"The current statutory language requires the Administrator to list any air pollutant which he intends to regulate and which he finds may reasonably be anticipated to result in an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness. After listing a pollutant, the Administrator has one year to establish a national uniform emission standard for each type of source of the pollutant that is strict enough to protect the public health with an ample margin of safety. Typically, there are at least a half dozen types of sources of a single pollutant—meaning that to list 10 pollutants in a year triggers a requirement to make at least 60 regulatory decisions the next. Furthermore, in some cases our assessment of source categories suggests that the public health risk is so small as not to warrant controls. The statute does not mention any factors other than health and safety that the Administrator is allowed to consider in making those regulatory decisons. It is not possible, without banning a substance, to establish safe levels for carcinogens, if by safe we mean entirely free from risk.

" The current statutory language can thus be read to require us to eliminate all risk from chemicals we list regardless of cost or social impact. Often the only way to eliminate risks would be to ban production and use of the chemical.

"In implementing section 112, we have taken it as a given that Congress did not intend us to eliminate these chemicals. We have made judgments about safety, and have attempted to balance many factors, including the nature of the risk and the cost of eliminating or minimizing it. In my judgment, the varied circumstances we face in this area make the authority to engage in such balancing efforts all the more imperative.

"If we are correct in this assessment, then Congress should move to make such balancing explicit in the language of the Act. If we are meant to act against chemicals for which we cannot establish a risk-free level without banning their use in every case, the statute should clearly say so and tell us what factors to weigh in stopping short of a ban.

"Any such test should certainly recognize the high value the American people place on public health and should assign it great weight in any balance that is struck. But the law should also recognize that the balance itself is necessary whatever weight a particular factor may be given.

"Increased flexibility to treat the varied nature of toxic air pollutants, exercised pursuant to Congressionally established criteria, would render the job of the Administrator of EPA possible and would make the goals of section 112 attainable.

"I understand Congress' impatience with the rate at which EPA has acted under section 112. As I testified before Chairman Dingell last fall, we are committed to working through most of our present backlog in the next few years. By doing this we will have examined and acted upon the health risks that may be posed by chemicals now being considered for listing. I believe that statutory amendments such as I have described that recognize the reality of the problems we face would help us in that task. Any such amendments must be based on an appreciation of the complex and varied nature of the problem of toxic air pollutants, not simply on a conclusion that everything must be done faster because too little has happened in the past."

Discussing the process of setting ambient air quality standards and the use of statutory deadlines for achieving them, Ruckelshaus commented:

"Since I returned to EPA a year ago, I have repeatedly stressed the importance of separating risk assessment from risk management. The process of setting ambient air quality standards and then requiring the use of deadlines to force their attainment illustrates this point. Under present law, setting standards is based solely on my determination of what is needed to protect public health or welfare. I have no quarrel with this approach as it is solely a risk assessment exercise.

"However, here is where the problem starts. Once set, the standards must be attained by fixed deadlines. It is in this risk management phase that I believe the Administrator should be given more flexibility. Nowhere does the statute explicitly provide for consideration of the economic or other impacts of attaining a given standard by a set deadline. Indeed, the statute can be read as saying that if the deadlines are missed, sanctions are automatically imposed. Prudent public policy demands that those charged with seeing that a goal is achieved be given the discretion to evaluate relevant factors. Historically, the statute has been read to provide this necessary flexibility. The law should explicitly provide it.

"Congress has recognized the problems with these deadlines in the past by extending them. The problem is not with the particular dates chosen, however, but with the inflexible nature of the approach. We are not repudiating the concept of deadlines. Indeed, even though many areas of the country are in the post-deadline period right now for some pollutants, our policy continues to make use of deadlines for most of these areas. But in some areas deadlines are simply unattainable.

"The Los Angeles region, for example, is clearly not going to be able to meet the 1987 ozone standard. In those areas, we have required states to adopt specific measures leading towards attainment of the standards rather than meet impossible deadlines. For that type of situation, we think it is appropriate to expect very strict but realistic and enforceable measures as a quid pro quo for extension of the deadline. The existence of a deadline that cannot realistically be met places us in the posture of being unable to act reasonably with an area that has done everything it knows how to do to meet the standards. This undermines the integrity of the law and tends to freeze people in place. We want to ensure real movement towards the standards, and we would recommend that a more flexible approach be adopted in achieving them." □

Twenty Lessons from Asbestos

A Bitter Harvest of Scientific Information

By Dr. Irving J. Selikoff, M.D.

Dr. Irving J. Selikoff

It seems that we sometimes learn most from our worst mistakes. This certainly was the case in one of the greatest public health disasters in modern times — cigarette smoking. When the marked increase in cigarette use began after World War II, there were few predictions of what was to occur in the 1960s, 1970s and 1980s.

More recently, nature has been similarly unforgiving with regard to asbestos, perhaps because we were reluctant to heed the warnings that we were given. It was found in 1924, for example, that exposure to asbestos could result in fatal disease. In that year, the *British Medical Journal* published a report by W. E. Cooke of a young woman who had worked with asbestos and who had died with extensively scarred lungs. In 1927, again in the *British Medical Journal*, he gave the disease the name it still bears, Pulmonary Asbestosis. By 1930, additional British studies demonstrated that such scarring was very common among workers exposed to asbestos and these observations were soon confirmed in our country by Fulton, Dreessen, Lanza and their colleagues as well as by other scientists. By the mid-1930s it was well established that asbestos inhalation could frequently cause disease and that such disease might be fatal. Scientific research since then has added much information but, in a sense, this largely defined the different ways that asbestos could kill. Thus, in 1935, Lynch and Smith in the United States and Gloyne in Great Britain, noted the association of lung cancer and asbestos work, and during the 1940s and 1950s cases of pleural and peritoneal mesothelioma were seen in asbestos-exposed workers. This association was clarified and firmly established in the first half of the 1960s by Wagner, Selikoff, Churg, Newhouse and others. Additional neoplasms (malignant growths) — again, further ways of dying — were subsequently found related.

We are now in the midst of widespread asbestos disease resulting from exposures during the past 60 years. So far, W. J. Nicholson has calculated that there have been more than 100,000 deaths of asbestos-associated disease and that we may look forward to more than 350,000 additional such deaths before the effects of past exposures run their course. These projections are concerned with cancer deaths from occupational sources. There will be additional excess cancer deaths from non-occupational exposures, as well as deaths from asbestosis, but it has not yet been possible to make appropriate quantitative predictions. Further, the predictions are predicated on the assumption that, after 1980, asbestos exposure will have ceased. Initial experiences suggest that this was a dubious assumption, and that the tragic toll of death and disease will extend longer than we thought. Moreover, the 9,000 or so excess cancer deaths from occupational sources now seen each year are accompanied by many times that number of workers with asbestosis of greater or lesser severity, with greater or lesser disability, but insufficient to directly cause death.

Inevitably, the observation of so much serious disease has led to increased understanding of the circumstances in which it has occurred, (as scientists sought to evaluate those factors) both for prevention of disease in the future and to provide help to those for whom prevention is now too late. There has also been the hope that what we have learned from the asbestos tragedy will provide principles that may help to prevent similar disasters in the future.

(Dr. Selikoff is Director, Environmental Sciences Laboratory, Mount Sinai School of Medicine of the City University of New York.)

TWENTY LESSONS

We have been taught much by the asbestos experience. This could be analyzed differently by the industrial hygienist, the regulator, corporate risk manager, clinician, industry executive, union official, pathologist, insurance company executive, lawyer, physiologist, economist, molecular biologist, and others. But perhaps the most pertinent lessons of all have been those gleaned from a public health point of view, from the perspective of how to prevent preventable disease. Twenty have been selected as being central to EPA responsibilities and concerns.

1. **Latency**: Although tissues and cells begin to react to the presence of inhaled asbestos fibers on a microscopic level within hours and days, clinical effects are not seen for years or decades. Even with the extensive exposure that was frequently found in asbestos factories in the past, it was commonplace to find no X-ray or pulmonary function change until five, ten, or more years had passed. These clinical probes are insensitive for demonstrating early changes. In one study of 1,117 asbestos insulation workers, regularly employed in the construction industry under circumstances in which significant exposure was the rule, more than half of those with less than 20 years from onset of exposure still had normal X-rays. After that point, most X-rays were abnormal. We should not expect to see early evidence of asbestotic change.

The same constraint is the rule for asbestos-associated cancer and for fatal asbestosis, as well. In a prospective study of 17,800 asbestos insulation workers, 1967-1976, relatively few asbestos- associated deaths were seen in less than 20 years from onset of their work exposure. Indeed, most deaths occurred 30, 40 or more years after exposure had occurred.

The disease and deaths now being experienced are the results of exposures in the 1940s and 1950s, with the 1960s beginning to make their contribution, the legacy of our mistakes of the past. Current exposures will not show their effects until the year 2010 and subsequently.

2. Irreversible errors: Once exposure has occurred (with one exception so far, see below) the die seems cast. We know of no way to remove or neutralize fibers in the lung or in other tissues (to which some migrate). Whether this is because of the residual fiber tissue burden or because of cellular and molecular changes is not known. From the point of view of prevention of future disease, control of human exposure, wherever and whenever it is occurring, is an emergency. Sometimes this is not appreciated. Somehow when the disease effect is 30 years off, there is little sense of urgency. This is wrong. There might be less complacency about friable asbestos in schools and public buildings if this were better appreciated.

3. Dose-disease response: Less asbestos, less disease; more asbestos, more disease. This central fact provides guidance for what is to be done. We may not be able to control every last fiber in the environment, but we can take some comfort in knowing that as our engineering and regulatory measures become more and more effective, there will be less and less disease. However, the "dose" of asbestos is cumulative, with newly inhaled fibers added to the burden already present. Therefore, each opportunity for asbestos exposure should be controlled not only because of its own hazard, but because it would be adding to the risk from other sources. This is a good example of the correctness of the definition of dose as "intensity x time."

With many agents, it is very difficult to ascertain "dose" associated with disease being seen, since the exposures responsible for such disease occurred decades before, when measurements were not made. Seidman and his colleagues have recently reviewed a unique set of circumstances demonstrating the dose-disease response nature of asbestos disease. They traced the long-term mortality experience of a large group of asbestos factory workers employed during World War II. They were all exposed to the same fiber, making the same products, using the same machinery, in the same plant. They differed, however, in one respect. Because of wartime conditions, some worked for a day, a week, a month, several months. Others worked from the time the plant opened in 1941 to when it closed in 1954. Since the intensity, for the groups involved, was the same, dose was proportional to duration of exposure. Lung cancer incidence for the various groups increased with increasing dose.

Two workers removing asbestos from a ceiling.

4. Disease with brief exposure: There have been numerous reports of relatively brief exposure and the subsequent occurrence of disease. However, many reflected individual experiences and for diseases such as lung cancer, they did not "prove" an association with short exposure.

The risk of brief exposure became better established with the study of mesothelioma, a neoplasm which has few known causes in humans other than asbestos. When mesothelioma is found, prior asbestos exposure is looked for and usually found. When asbestos exposure occurs, there is significant risk of subsequent mesothelioma. The extraordinary relationship between asbestos exposure and mesothelioma was perhaps best considered by Cochrane and Webster. They interviewed 107 patients in whom the diagnosis of *mesothelioma* had recently been established by biopsy. In 106, potential prior exposure to asbestos was elicited. The experiences of Seidman et al (see above) have provided the necessary population-based data to confirm the keen clinical observations previously made.

The mechanism by which brief exposure subsequently results in disease is not known. It may be related to the retention of fibers in tissues but it may not. The same phenomenon is seen in bladder cancer following exposure to beta-naphthylamine or benzidine or in angiosarcoma of the liver after vinyl chloride exposure where there is no evidence for retention of the chemical carcinogens.

5. Disease with low-level exposure: The dose-response relationship for asbestos appears to be linear. This predicts disease with low exposures. The model has been shown to be correct. In 1965, Newhouse reported mesothelioma among individuals whose only known exposure had occurred as a result of residence in households of asbestos workers, or by virtue of living within a half-mile of an asbestos plant in London. Such family contact and neighborhood exposure mesothelioma has been widely confirmed and its importance documented. Of course, it can be argued that such exposure is not "low," particularly since it results in a significant amount of disease (in one current study, lung cancer risk appears to be about doubled and mesothelioma to be responsible for approximately 1% of deaths occurring 20 or more years following the initiation of household contact exposure).

What will happen at the lowest levels of exposure is still not known. There are other uncertainties. Brief exposure, if fairly intense, produces disease. Long-term exposure, at relatively low levels (household) produces disease. It is not known whether brief exposure to low levels will produce detectable disease. Complicating such analyses is the cumulative nature of even low-level exposure. The problem is not unique to asbestos; it is also the case with PCBs, dioxins, etc. This again points to the necessity for control of all sources.

6. Multiple factor interaction: It has long been suspected that much human disease from exogenous sources is multifactorial in nature. Asbestos taught us that this is indeed so. When the experiences of the 17,800 asbestos insulation workers, with smoking habits known and observed prospectively, were compared with those of 73,736 like men in the American Cancer Society's prospective study of cigarette smoking, a remarkable multiplicative effect was seen. Men who did not smoke and did not work with asbestos suffered 11 deaths per 100,000 man-years. For asbestos workers who did not smoke, it was five times as much, 58. On the other hand, individuals who smoked but did not work with asbestos had a death rate of 122 per 100,000 man-years, and men who had both exposures, asbestos and cigarette smoking, had 601. There is evidence that the same cigarette smoking-asbestos interaction may explain the increased risk of cancer of the esophagus, oropharynx and buccal cavity, and larynx. There is no such interaction, however, for mesothelioma, cancer of the stomach, colon-rectum or kidney — both smokers and non-smokers suffer equally.

Conclusions important for prevention may be drawn. First, all individuals known to have been exposed to asbestos should never start smoking or, if they are smoking, should stop immediately. This is particularly important since data indicate that there can be reversal of risk once smoking ceases. Asbestos insulation workers who stop smoking, after 5-10 years, have about one-third to one-half the risk of lung cancer of their mates who continue to smoke. While cancer, once it occurs, is not reversible, cancer *risk* may be. A corollary conclusion, however is inherent in the above observations. Since smoking cessation will not affect risk of mesothelioma or the other neoplasms not associated with smoking, it will be equally necessary to control asbestos exposures. Both measures are needed.

7. Product use: For every worker employed in the manufacture of asbestos products, there may be 500 who would use them or be exposed indirectly during such use. It is therefore unfortunate that at the outset of our asbestos experience, we thought of "asbestos workers" — men and women employed in mining, milling or factory work. The first phase of asbestos exposure and accompanying disease was associated with *product manufacture*. Later, during the last 40 years or so, there was increasing attention to disease associated with *product use* in the construction industry, shipyards, powerhouses, chemical plants and refineries, brake maintenance and brake repair, etc. We are now entering a third phase — in which asbestos exposure will be associated with *environmental exposures*, during repair, renovation, removal, and maintenance of the asbestos put in place during Phase Two. We have learned the difficult lesson of not thinking of asbestos workers, but asbestos-exposed workers.

8. Industrial origin of environmental disease: The factory gate and the factory fence are porous. Almost all asbestos exposure is industrial in origin, although some fibers derive from erosion of natural outcroppings, and water may be contaminated as it filters through asbestos rock formations. Such environmental contamination is very limited, however, particularly in terms of disease.

9. Multiple effects/multiple agents: Asbestos can produce a variety of illnesses, ranging from pulmonary and pleural fibrosis to lung cancer, pleural and peritoneal mesothelioma, gastrointestinal cancer, cancer of the oropharynx and buccal cavity, laryngeal cancer, and kidney cancer. Other effects, too, are now being seen, including immunomodification and serological changes. The other side of the coin, important from a diagnostic point of view, is that virtually all of these diseases and modifications can be caused by other agents, as well. Even mesothelioma, so highly attributable to asbestos, can be found to have other causes. Already, erionite has been seen to produce pleural and peritoneal mesothelioma among residents of Cappadocia, Turkey, and there is considerable concern that other materials, particularly man-made fibers, may eventually be associated with mesothelioma risk.

10. Environmental persistence: It has been said that asbestos has "a half-life of infinity." This is remembered ruefully as one considers the 30,000,000 tons of asbestos put in place from 1900 to 1980, in our ships, buildings, schools, chemical plants, refineries, powerhouses, factories, etc. Approximately 700,000 tons of insulation materials were installed in the same period; much remains.

11. Complexity of initiation and promotion: There has been much scientific interest in recent years concerning the concept that carcinogenic agents may either initiate the cancer process or, once initiated by other agents, promote its development. Asbestos seems to do both, according to circumstances. Thus, for lung cancer, the data suggest that it acts as a promoter, multiplying the background risk at each attained age. A 50-year- old individual has a much greater background risk of lung cancer than, let us say, one who is 20. Asbestos, in each, multiplies that risk. It therefore does not achieve very much to restrict hiring to older workers, in the hope that latency would give them a very long life before lung cancer might strike. Two latencies have to be considered — background exposure and asbestos. This would apply, for example, to teachers in asbestos-laden schools. Their risk depends upon their age as well as their prior asbestos exposure. A 55-year-old teacher with only 10 years in such a school nevertheless has important risk.

On the other hand, since there is little background risk of mesothelioma, asbestos acts as an initiator with risk increasing with age by approximately a power of four. Again in school circumstances, this points to the importance of prevention of exposure of children, with long lives ahead of them.

12. Complexity of societal consequences: It has long been a truism that, from an ecological and environmental point of view, everything is related to everything else. With asbestos, this dictum applies to other circumstances, as well. Current litigation has been marked by bankruptcy of major industrial firms, thousands of lawyers face each other in courts clogged by suits seeking help and redress, insurance companies are concerned with potentially monumental costs. It has been variously estimated that asbestos disease payments to victims will range between 40 and 150 billion dollars. In addition, Professor William G. Johnson of Syracuse has calculated that social costs of asbestos disease due to previous exposure will total more than three hundred billion dollars. Industrial practices are changing, with the advent of substitute materials, many of untested toxicity. Doubt has even been cast on the effectiveness and applicability of the workers compensation system.

We are also beginning to see another legal tangle, perhaps of equal or greater complexity, with legal battles shaping up over who is to pay for the expense associated with abatement of asbestos in schools and public buildings.

13. Early utilization of industrial hygiene engineering: Failure to respond early to information concerning the disease potential of asbestos carried with it the omission of measures needed to control exposure. Asbestos became entwined in industrial procedures with hazards intact. When, decades later, there was increasing concern with disease potential, it was doubly difficult to change uses and procedures integral with the entire fabric of industrial production. Moreover, since the industrial engineering measures that were needed were being telescoped into a relatively short period of time rather than having been accomplished over many years, attendant costs were correspondingly high. To further complicate matters, these costs had to be borne at a time when the product itself was being questioned and sales were decreasing.

14. Disadvantages of fragmentary regulatory approaches: There has been less than complete interaction and interdigitation of knowledge, experience, research, regulatory actions. Dreessen of the U.S. Public Health Service undertook a rather elegant study of asbestos disease potential in the early 30s (published in 1938). I expect that it was hardly known to the National Cancer Institute's Advisory Council when, in 1951, it rejected a proposal by Leroy U.Gardner, then dean of experimental dust disease pathologists, to study cancer potential of asbestos in animals (he had early hints of such findings in his pneumoconiosis experiments).

There has been less than complete integration of the interests and studies of the EPA, NIOSH, NIEHS, CPSC, NCI. Fortunately, mechanisms exist for such interdigitation.

15. Science is necessary but not sufficient: When, in the latter half of the 19th Century, it began to be found that serious human disease could be caused by exogenous agents (infectious) a revolution in scientific thinking began; there was now not only description, but causation. (It is instructive to appreciate how recent this has been; 1982 was only the one hundredth anniversary of the discovery of the tubercle bacillus by Koch.) It was soon found that the identification of causes could be followed by their control. Pasteurization of milk, sewer systems, and clean water supplies were put in place. In the first half of the 20th Century, we again applauded those who discovered still other causes of disease, often metabolic, endocrine, or nutritional.

The same approbation has not inevitably met those studies which have identified some of the newer exogenous causes of disease. The tobacco industry has given no testimonial dinners to the researchers who have shown that this year we might expect more than 100,000 deaths of lung cancer due to cigarette smoking (plus additional excess deaths of pancreas, bladder, oropharyngeal, esophageal and larynx cancers, plus deaths of cardiovascular disease and emphysema). As we consider 8-naphthalymine and benzidine, 4-aminobiphenyl, nickel smelting, arsenic, vinyl chloride, lead, cadmium, chromium, etc., we are reminded that, in the 1890s, there were no trade associations for the protection of the cholera vibrio or the tubercle bacillus, no firms producing salmonella, no public relations groups operating on behalf of the pneumococcus, the diphtheria or the staphylococcus.

It has become clear that, just as in the 1890s, scientific research is necessary for the identification of causes of disease. But the simple gathering of data is only one part of the process. Utilization of the information is also required. Regulatory measures are needed, often of considerable complexity.

16. Indoor air pollution: It took some little time before it became clear which agency was going to consider itself responsible for indoor air pollution with asbestos. The complexity of the problems being found make such bureaucratic reluctance understandable. Nevertheless, in view of the very large number of people involved, this has become increasingly important. Perhaps the late acceptance of responsibility, as well as the late identification by scientists of the potential importance, help to explain the paucity of exposure data now at hand.

17. Recruitment of constituencies: An important asbestos lesson, perhaps related to what has been said before about science being necessary but not sufficient, has been the increasing understanding that application of knowledge can be speeded when those who are directly affected have the information that intimately concerns them. OSHA operates best, perhaps, when both labor and industry are aware of the facts that form the background for OSHA regulations. EPA's requirements that parents and teachers be told of asbestos findings in schools, is of this genre. Control of asbestos exposure depends at least as much upon understanding at the shop floor, as upon intricate regulations ensconced in the *Federal Register*. If we don't have understanding of what has to be done on the part of supervisory personnel and workers, there will never be enough inspectors to insure safety. With understanding, we will need few.

All this translates into an important educational function for EPA!

HOW MANY ANGELS ON THE HEAD OF A THRESHOLD?

18. Disease: There are learned and often esoteric discussions of how much disease might be expected at very low levels of exposure. Calculations are made and projections offered. It will be very difficult to verify or contradict these. Epidemiologically, very large populations will be required, carefully defined as to biases and variables. Since few cases of disease are expected at such levels, it is unlikely that the vast resources necessary for these studies will ever be made available. Animal experiments at very low levels will always have the disadvantage of insecurity with regard to extrapolation to humans.

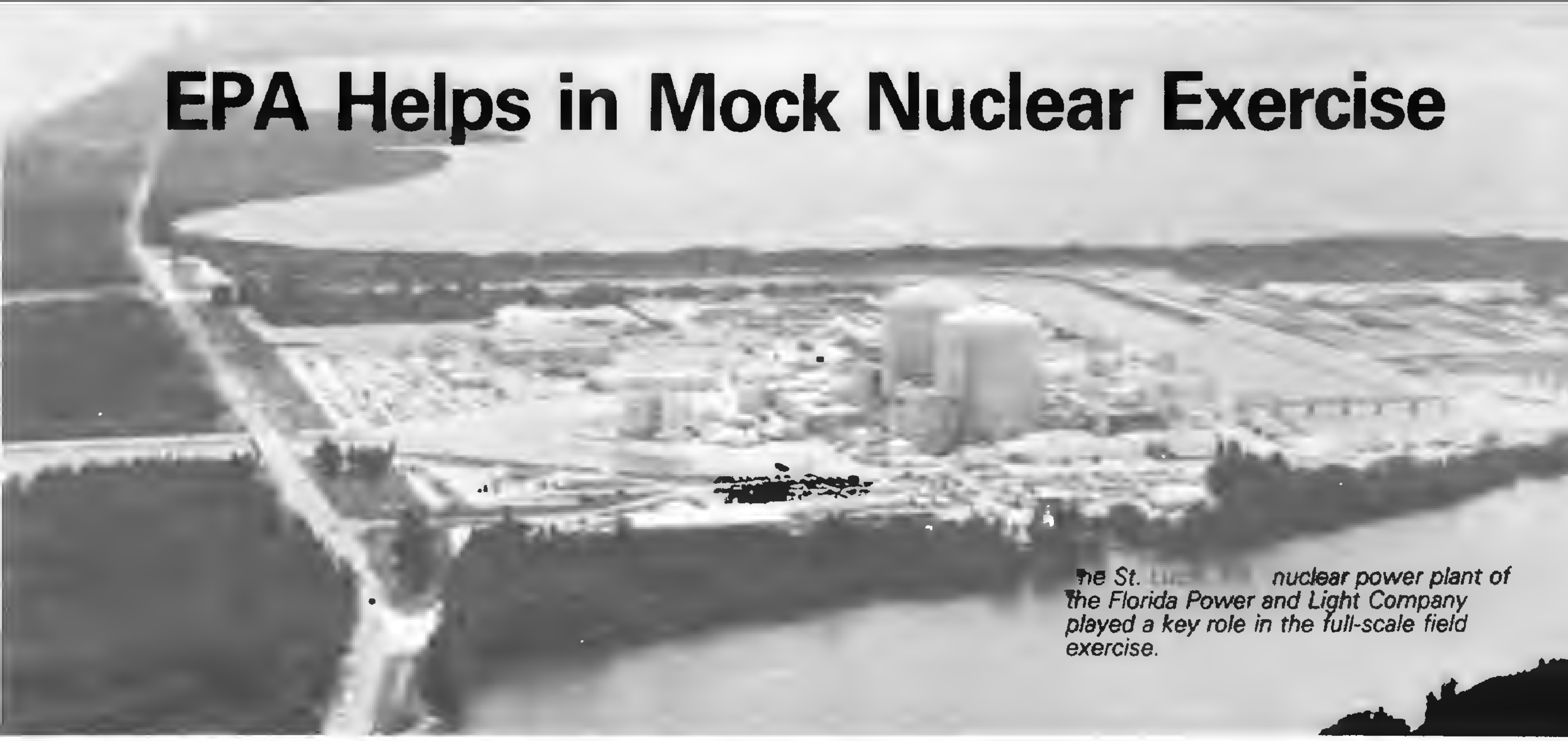
The discussions, while interesting and important from a regulatory point of view, nevertheless have an air of unreality at this moment, with workers still being exposed to permissible levels of more than 20 million fibers per day; these estimates refer to longer fibers and do not take into account the very much larger number of shorter ones which accompany them but are not counted. Concern about very low levels seems somewhat out of touch with reality while some schools have levels of 100 to 1,000 nanograms and while maintenance and repair work on asbestos materials is often undertaken without precautions or supervision.

19. Limitations of epidemiology: These are widely acknowledged — evidence is based upon human disease that has already occurred, available methods are insensitive in detecting other than very gross and marked effects, studies are not suitable for smaller populations, there is frequent lack of concomitant exposure data, etc. Further, with the inevitable biases and variability inherent in human population studies, residual uncertainties persist and sometimes the best that can be achieved is the acknowledgment of "associations" rather than definitive causation.

Yet for asbestos disease, epidemiology has served us well and we have had only limited assistance so far from animal studies. It is to be hoped that in coming years, with other agents, we will no longer have to depend so heavily on epidemiological studies of human experience.

20. The concept of "industry" identity: There is probably no such thing as a monolithic industry, each sector being identical with all others. Some industry units are knowledgeable, others not. Some are concerned and truly responsible, others couldn't care less. Who, then, speaks for "industry"? My own experience with asbestos problems indicates that trade associations do not always speak for the most knowledgeable and the most involved industry units. This can be an important disadvantage. ☐

EPA Helps in Mock Nuclear Exercise



The St. [illegible] nuclear power plant of the Florida Power and Light Company played a key role in the full-scale field exercise.

Edwin L. Sensintaffar, Montgomery, Ala., places the filter on a high-volume air sampler for one of EPA's environmental monitoring stations. Radioiodine sampler and gamma exposure rate equipment are also shown.

To test the new Federal Radiological Emergency Response Plan, officials from EPA, the Federal Emergency Management Agency, and other federal, state, and local agencies conducted a mock exercise recently. The objective was to test the effectiveness of plans to help cope with a simulated nuclear power plant accident on the eastern coast of Florida near Ft. Pierce. EPA radiological specialists from agency laboratories in Montgomery, Ala., and Las Vegas, Nev., as well as representatives from the Office of Air and Radiation and the Office of External Affairs from EPA's headquarters in Washington played roles in the exercise.

Mark O. Semler, Montgomery, Ala., reviews output from the gamma spectrum analyzer in EPA's mobile radiation counting laboratory.

Michael F. O'Connell of the Las Vegas laboratory measures the gamma radiation exposure as Edwin L. Sensintaffer of the Montgomery laboratory collects a vegetation sample to document radioactive deposition.

Learning to Control Dioxin

An Interview with Erich Bretthauer

Erich Bretthauer represents the Office of Research and Development on EPA's Dioxin Management Task Force and coordinates the Office's dioxin research. Bretthauer, who has been with EPA since its inception, is also Director of ORD's Office of Environmental Processes and Effects Research. He is a chemist.

Q Why is the chemical dioxin of such great concern?

A There are eight classes of chlorinated dibenzo-p-dioxins. The classes depend on the number of chlorine atoms in the molecule. One form in particular, 2,3,7,8 tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD), has been shown to be extremely toxic in animals at very low levels and to persist in the environment.

Q What are the toxic problems with 2,3,7,8-TCDD?

A In laboratory animals, 2,3,7,8-TCDD has been demonstrated to be toxic to fetuses, to have the ability to cause birth defects and to cause cancer.

Q How did the dioxin problem first develop?

A The toxic 2,3,7,8-TCDD was first identified in 1969 as an unavoidable contaminant of 2,4,5 trichlorophenoxyacetic acid (2,4,5-T), a popular herbicide at that time. It was also found in Agent Orange which contained 2,4,5-T. In 1974, 2,3,7,8-TCDD was recognized as a component of the wastes from the manufacture of 2,4,5-TCP, a fungicide and disinfectant. In 1979, Dow Chemical Company announced that dioxin was associated with certain combustion processes.

Erich Bretthauer

Q Is it possible that the danger from dioxin has been exaggerated in the public mind?

A. The toxic potential of dioxin in its pure form in all laboratory animal studies to date is very clear and it certainly is a very toxic compound. However, the fate of this material, how it moves in the environment, how biologically available it is to humans, animals and plants and its food chain magnification potential are poorly understood at this date. Because of these uncertainties the risk of dioxin to humans may actually be smaller than we currently now believe

Q What is EPA trying to learn about dioxin in its research program?

A EPA's dioxin research program is multi-faceted. There are several important components. The first is to understand better the sources of dioxin in our environment. We know of some but not all potential sources of dioxin. Work is continuing in an effort to define the relative contribution of each of these sources to the total dioxin problem. For example, we would like to determine better the magnitude of the dioxin problem from incineration. We would also like to know how much comes from the production and use of pesticides.

Q What about bio-accumulation studies?

A Bio-accumulation studies are a very important component of our work. We hope to understand to what extent dioxin is accumulated in the human body, animal tissue, and in various types of plants in order to assess the likely risks of dioxin to humans.

We don't know at this time how biologically available the various forms of dioxin are that we find in our environment. For example, there are reports from laboratory studies that dioxin attached to, or found in, soil in one particular area has a negligible bio-availability. But similar studies recently conducted with dioxin on other soils from other areas show a significantly greater bio-availability. Thus most dioxin measurement methods, which rely on extraction with strong chemicals, may not accurately represent the hazard to man.

Q Is it possible that plants may be used to clean up dioxin pollution through bio-accumulation?

Mike Clemons, EPA Region 7, holds a hand auger while Keith Schardein, Missouri Department of Natural Resources, removes a soil sample to test for dioxin in Times Beach, Mo., in December, 1982.

A We know that certain types of plants do accumulate metals from the soil in which they are grown. We are evaluating as a part of our overall dioxin research program whether there are plants which preferentially take up dioxin from contaminated soil. However, given the concentrations involved and the chemical structure of dioxin, it seems unlikely that this method will provide an effective control strategy.

Q What about other areas of ORD's dioxin research program?

A Another important part of our research program relates to what we can do about the areas that are currently contaminated with dioxin. We have several important research projects underway to determine how to reduce the hazard of contaminated soils to man.

We also have some research underway to develop methodologies to measure the extremely low levels of dioxin found in the environment. We are interested in measuring levels of dioxin significantly lower than we're usually interested in for other pollutants in our environment. For example, in our dioxin water surveillance studies we are interested in measuring levels in water below a part per trillion in contrast to analysis of metals in water where we are usually interested in concentrations in the parts per million range.

Q What are the units of the Office of Research and Development that are involved in dioxin research?

A Many of our research laboratories are involved. Our Municipal Environmental Research Laboratory in Cincinnati is conducting research to determine where and under what conditions dioxin is formed in our environment. The laboratory is also conducting research with several chemical compounds to actually detoxify dioxin in soil.

Our Environmental Research Laboratory in Ada, Okla., is conducting work to determine the persistence of dioxin in soil and how long it exists under which conditions in our environment and how it moves in soil systems.

We also have work going on in our Municipal Environmental Research Laboratory in Edison, N.J. which is evaluating thermal destruction techniques for dioxin-contaminated soil.

Q What about research on the effects of dioxin in humans?

A Our Office of Health Research and our Office of Health and Environmental Assessment in collaboration with the National Institute of Environmental Health Sciences have several programs underway. One such program will determine how dioxin is metabolized in the body, using a species closely related to man, the rhesus monkey.

These studies utilize female rhesus monkeys which have a metabolism similar to humans. These monkeys were fed a very small amount of dioxin over a four-year period. Current studies will determine the rate in which dioxin is excreted from the fat in their bodies. In addition, when some of these monkeys are bred, and have offspring, concentrations of dioxin will be measured in their breast milk.

In animal studies, dioxin is embryotoxic; that is offspring with reduced birth weight result after maternal exposure. We are conducting some epidemiological studies in conjunction with the State of Missouri to determine if unexpected increases in childhood cancer as well as low birth weights of children in local areas of Missouri exist, and if so, whether these increases correlate with the time of dioxin exposure.

Also in the area of health research we are working to develop a monoclonal antibody, one specific and sensitive for 2,3,7,8-TCDD. The purpose here is the eventual production of an antibody suitable for detection of dioxin in human blood or even environmental samples at the parts per trillion level. It may even serve as a tool to give us more information about the dioxin molecule itself.

Q Are there other aspects of the dioxin problem that the Office of Research and Development is researching?

A We're conducting work in our environmental research laboratories in Duluth, Minnesota, and Corvallis, Oregon, to determine the bioavailability of dioxin from contaminated soils to fish, plants, and grazing animals. These studies will provide information on food chain magnification of dioxins. In addition, our environmental monitoring laboratories in Las Vegas, Cincinnati and Research Triangle Park are working on quality assurance procedures, methods and measurement techniques to detect dioxin at very low levels in soil, air, water, and fish tissue samples.

Q What are the main techniques being studied to dispose of dioxin? Are any currently usable or operational?

A We're studying several techniques. A promising one is to treat soil with a chemical compound and sunlight. The compound that we're studying at the present time is an alkali metal in a polyethylene glycol base solution. This chemical seems to hold good promise for actually breaking the chlorine bond, and thus detoxifying the dioxin molecule. This process may be enhanced by ultraviolet radiation in sunlight.

In addition, we have a soil-washing technique under study. We'll actually wash the soil with certain chemical solvents to try to solubilize the dioxin in order to remove it from the soil. Subsequently, we may incinerate the solubilized dioxin. We also have a program underway to evaluate the feasibility of actually burning soil in an incinerator as well as efforts to evaluate stabilizing dioxin on soil using chemical techniques.

All of these types of studies are underway at the present time. Some of them are proceeding from the laboratory scale to the field scale for evaluation. And this summer we'll be performing field work with the chemical stabilization techniques. We also hope to test our soil washer and incinerator to see how practical it is for detoxifying dioxin-contaminated soil.

Q Is it possible to lick the dioxin problem?

A I'm very optimistic that the research which is currently underway, both in this agency and in other agencies, will allow us to better understand the true risk of dioxin-contaminated soils to humans. I also believe that the control technology research being done here at EPA will provide more and better options for effectively dealing with dioxin contaminated soil. So yes, I believe that we can adequately address the dioxin problem.

Q Isn't the cost of dealing with the dioxin problem going to be enormous?

A Cost certainly is an important factor. Our control options research will provide cost information for each option.

Q How does the Office of Research and Development fit into the overall EPA dioxin control plan?

A Our research is designed to support the agency's overall strategy. It is designed to get a better estimate of the risks of dioxin to humans and to develop remedial techniques we might use to improve, control, or minimize risk. Also we are providing technical guidance for the various field investigations that are currently underway and various types of technical support in terms of quality assurance samples and measurement methods for the various EPA regional programs.

Q Can you estimate the budget of the Office's dioxin research program?

A We have about $2.5 million dollars devoted to dioxin research in Fiscal Year '84 and expect a similar amount in Fiscal Year '85. Two million dollars of that work is extramural and supports work in universities and other institutions.

Q Will what we are learning about dioxin help in dealing with other dangerous chemicals?

A We're very optimistic that some of the dioxin research will be beneficial in solving other environmental problems. For example, if we are able to develop monoclonal antibodies to estimate very low levels of dioxin in exposed humans, this will indeed provide a valuable research tool which we might use to estimate the amount of other hazardous materials to humans such as the toxic by-products of PCB's and dibenzofurans. One might even envision a battery of antibodies capable of measuring a number of toxic substances in blood without using more invasive procedures such as surgical removal of tissues and elaborate expensive laboratory procedures such as mass spectroscopy. □

The Research Behind a Clean Air Proposal

An inlet measuring particulate matter on a rooftop in downtown Durham, N.C. New particulate samplers, and new inlets on old samplers, are also being tested in Los Angeles, St. Louis, and Phoenix. The samplers will be used in EPA's nationwide Inhalable Particulate Network.

Where do environmental standards come from? It is part of the job of the Environmental Protection Agency, as a regulatory body, to set new environmental standards and reevaluate old ones for possible revision.Standards issued under the Clean Water Act, for example, govern oxygen supply and microbiological content of surface water. Resource Conservation and Recovery Act standards govern hazardous wastes. And Clean Air Act standards regulate amounts of certain pollutants in the air and emissions from power plants and other sources.

Any one of these standards may affect the health of millions of people. Compliance may cost industry millions of dollars. So when EPA sets out to change a standard, it bases revisions on the best available science.

This article describes how the procedure worked in one case, when EPA undertook to revise the National Ambient Air Quality Standard (NAAQS) for total suspended particulate matter. In the process, the agency faced many complicated questions — for example, where to set the numerical limit of the 24-hour and annual standards. This article focuses primarily on the reasoning behind the decision to regulate only particles of a certain size.

Change in focus

On March 9, 1984, EPA Administrator William D. Ruckelshaus proposed major revisions of national ambient air quality standards for particulate matter, changing the pollutant regulated from total particles in the air irrespective of size to inhalable particles that are widely acknowledged to be more damaging to human health (see *EPA Journal*, April 1984). Under the Clean Air Act, the agency had established the first standard for particulate matter in 1971. The revisions now being proposed are the result, not of any instant decision, but of a complex and lengthy process that began eight years ago, in 1976.

At that time, the National Air Quality Criteria Advisory Committee advised review of the standards for six principal air pollutants. The following year, Congress amended the Clean Air Act. The new legislation *required* EPA to review air quality criteria and ambient standards every five years and, where appropriate, to revise them. New standards were to be based on the best scientific information.

The process for revising a national ambient air quality standard includes five major steps: 1) compilation of relevant scientific information into a *criteria document*, 2) evaluation of criteria document information in a *staff paper*, 3) recommendation by the Clean Air Scientific Advisory Committee (CASAC), 4) publication of the proposed standard in the *Federal Register*, and 5) promulgation of the final standard. The whole process is enormously complex, "an ambitious undertaking," according to Ruckelshaus, "spanning many years and requiring input from many scientists, health experts, environmental officials, and the interested public." Revision of the particulate matter standard involved dozens of EPA offices and laboratories, hundreds of scientists, and thousands of studies - nearly 3,000 in all.

What is particulate matter?

Particulate matter (PM) in the atmosphere comes from both natural and manmade sources. Natural sources include wind blown soil, sea spray, volcanos, and forest fires. Manmade particulate emissions originate from automobile exhausts, power plants, and activities like construction that stir up dust and dirt.

Inhaling particulate matter can affect breathing and the respiratory system, aggravate existing respiratory and cardiovascular disease, alter the body's defense systems against foreign materials, damage lung tissue, and contribute to premature mortality. People likely to be most sensitive to effects of particulate matter are those with lung or heart disease, influenza, or asthma, plus the elderly, preschoolers, and people who breathe through their mouth.

At elevated concentrations, particulate matter can also affect visibility, climate, and vegetation. It can soil materials and become a nuisance.

The first standard for particulate matter that EPA had established back in 1971 covered total suspended particulate matter (TSP). TSP measurements included "anything that could enter the sampler," according to Dr. Fred Miller of EPA's Health Effects Research Lab in North Carolina. Large particles 30-50 micrometers in size were being measured. But, says Miller, particles that big "don't get into the lungs, and we wondered, 'What do these particles have to do with pulmonary effects?'"

Human studies relating to the particulate standard were conducted at the Clinical Studies Branch of the Health Effects Research Lab (HERL), located on the campus of the University of North Carolina Medical School at Chapel Hill. At this lab, volunteer subjects were exposed to ambient levels of water soluble particulate matter, alone and in combination with ozone, nitrogen dioxide, and sulfur dioxide. The studies showed the effects of the different pollutants on lung function. According to Branch Chief Dr. John O'Neil, the research project on inhaled particulates studied the responses of over 325 volunteers, and took over three years to complete.

Animal studies for the particulate standard took place in HERL's Toxicology Branch.Unlike human studies, animal studies used exposures over long periods of time and provided for more detailed examinations of the lungs.

Miller headed a task force of EPA scientists and technical experts who addressed the question of health effects of particulates in 1978. Drawing upon their own research and several other published studies, the authors examined the distribution of various kinds of particles in the atmosphere and the manner in which such particles were deposited in the human respiratory tract. In a 1979 article, "Size Considerations for Establishing a Standard for Inhalable Particles," published in the *Journal of the Air Pollution Control Association*, the group recommended that research to develop a size-specific standard focus on inhalable particles (less than 15 micrometers in size) that can penetrate to the lower respiratory tract. The group also recommended a focus on fine particles (less than 2.5 micrometers in size) because of the composition of such particles in the atmosphere. That same

year, EPA set up an Inhalable Particulate Network of about 100 monitoring stations to measure the distribution of inhalable and fine particles in various U.S. cities.

Since particulate matter is likely to be a health concern chiefly when it reaches the lower respiratory tract, and since large particles *do not* reach the lower respiratory tract, the need to control them is questionable, according to Dr. Miller. This reasoning eventually led to the shift in the standards from larger particles to smaller ones now being proposed.

Criteria document

The first step in revising the particulate standard was preparation of a criteria document. Mike Berry of EPA's Environmental Criteria and Assessment Office in North Carolina was heavily involved in that effort. By 1978, according to Berry, work on the criteria document had begun in earnest.

A criteria document is an extensive review of the relevant scientific information on a pollutant. Some of that information comes from studies carried out at laboratories that are part of EPA's Office of Research and Development (ORD). Much of it comes from other sources such as universities, utility and chemical companies, the National Institute of Occupational Safety and Health, and the National Institutes of Health.

In addition to carrying out standards-related research, EPA lab staff performs the equally important tasks of reviewing and interpreting outside research.

EPA lab scientists, consultants, and staff of ORD's Environmental Criteria and Assessment Office where Berry works all contributed to the writing of the criteria document on particulates. "We tried to be objective scientists," says Berry."We

At EPA's Health Effects Research Laboratory in North Carolina, a scientist checks data on volunteer undergoing a multi-gas rebreathing test. The volunteer, seen through the window in the background, is in an exposure chamber, breathing ambient levels of test pollutants while exercising on a treadmill. Through a device called a pneumotach, he is connected to a machine that measures cardiovascular output and changes in functional capacity of the lungs. The measurements are displayed on the terminal seen here.

weren't looking for evidence to support a particular regulatory decision.We simply tried to describe the effects of a pollutant objectively."

Different specialists managed different parts of the document, reviewing thousands of citations as part of the literature search. The document then underwent an extensive and rigorous peer review process.

By April 1980, a first draft of the criteria document on particulate matter was ready. Two years and three drafts later, the final document was released. It contained more than 1,400 pages in three volumes.

Staff paper

After the Office of Research and Development prepared the criteria document on particulates, the Office of Air and Radiation (OAR) took the next step when its Office of Air Quality, Planning, and Standards, located in North Carolina, prepared the staff paper. This document, its authors write, "is intended to help bridge the gap between the scientific review contained in the criteria document and the judgments required of the Administrator in setting ambient standards for particulate matter. As such, particular emphasis is placed on identifying those conclusions and uncertainties in the available scientific literature that the staff believes should be considered..."

The final staff paper strongly recommended that EPA move from regulating all particles regardless of size to regulating small particles only, and examined the possibility of alternative size-specific indicators as well as chemical classes (such as sulfates). With the concurrence of the Clean Air Scientific Advisory Committee, the authors recommended a size-specific standard, stating:

"The current TSP standard directs control efforts towards particles of lower risk to health because of its inclusion of larger particles which can dominate the measured mass concentration, but which are deposited only in the extrathoracic region. A new particle indicator representing those particles capable of penetrating the thoracic regions...is recommended. The size range should include those particles less than a nominal 10 micrometers..."

John Bachmann was a principal author of this staff paper. He describes how the decision was made to switch from total suspended particulates to PM_{10} (particulate matter 10 micrometers or smaller). "Research showed that the least obnoxious particles were being deposited in the least sensitive area," Bachmann explains. "But the smaller particles were being deposited in the lower regions of the respiratory tract, where they could do the most harm. We felt we should concentrate on the particles that could have the worst health effects." According to Bachmann, the 10 micrometer size that had been recommended by the International Standards Organization and supported by the Clean Air Scientific Advisory Committee represents a logical refinement of the original 15 micrometer definition of inhalable particles. The Inhalable Particulate Network is now being retrofitted for the 10 micrometer measurements.

By June 1981, a first draft of the staff paper had been completed. Six months and two drafts later, the final, 252-page document was released.

CASAC review

The Clean Air Scientific Advisory Committee (CASAC) is one of four permanent standing committees of EPA's Science Advisory Board. The Clean Air Act specifies that at least one physician, one member of the National Academy of Sciences, and one representative of a state air pollution control agency should serve on the seven-member committee. Members are appointed by the Administrator.

The Committee was heavily involved right from the start in revision of the particulate standard. At a public meeting in November 1978 the Committee made the recommendation, subsequently adopted, that information on particulate matter and sulfur oxides be combined in one criteria document. (Proposed revisions in the sulfur oxides standard are still under development.) The Committee also reviewed each of many drafts of both the criteria document and staff paper, and submitted reports on both documents to the Administrator. "EPA's practice," says Ruckelshaus, "is to make the criteria document final only after the Clean Air Scientific Advisory Committee, a Congressionally mandated group of independent scientific and technical experts, is satisfied that the document contains an adequate assessment of the latest scientific knowledge."

Where we are now

The particulate standard work of the Office of Research and Development, the Office of Air and Radiation, and the Clean Air Scientific Advisory Committee culminated on March 9, when Ruckelshaus announced the proposed revisions. As explained above, the proposal calls for replacing the current primary (health-related) standards for total suspended particulate matter with a new indicator that includes only particles 10 micrometers or smaller. The agency is also proposing that: 1) the new 24-hour primary standard be a number selected from a range of 150-250 micrograms per cubic meter of air, 2) the annual primary standard be a number selected from a range of 50-65 micrograms per cubic meter of air, and 3) the new secondary (welfare-related) standard replace the current 24-hour TSP secondary standard with an annual TSP standard selected from a range of 70-90 micrograms per cubic meter of air.

A 90-day comment period on the proposed revisions began March 20, the date they were published in the *Federal Register*. According to Ruckelshaus, it will take about one year for EPA to review all comments received, assess any new information, and develop and promulgate a final standard.

* * * * *

This article has focused on the scientific groundwork for the proposed particulate standard revisions. It has not discussed some of the non-scientific issues that were involved, such as litigation to accelerate review of the criteria document. And it has not discussed some of the issues that will come into play now that the revisions have been proposed — issues like risk management and state implementation. The law requires that public health should be the sole criterion for setting primary standards, and that economic and technological feasibility may not be considered. Despite the fact that, as Ruckelshaus said, "even a seemingly minor revision in these standards can trigger major regulatory consequences," the Administrator is not allowed to consider practical problems of implementation in selecting a specific number from the range recommended for the new 24-hour primary standard. □

Science Highlights:

The targets of EPA's research and development range from ground-water contaminants deep in the earth to air pollution movements high overhead. In this article, EPA science writer Richard Laska highlights some recent advances.

How to catch a virus

There are more than 100 different types of human viruses which can be transmitted by drinking water. Most of these viruses are extremely small — it would take 1,000,000,000,000,000,000 to fill a ping pong ball — and yet exposure to a very few virus particles can cause illnesses ranging from intestinal cramps to heart, liver or central nervous system disorders. In some cases, these viruses are not adequately removed by chlorination or other wastewater treatment processes. Coming from sewage effluent or sludge, these viruses can enter drinking water supplies where they are, understandably, extremely difficult to detect.

"You're looking for 10 or 20 particles in 100 gallons of water," notes researcher Robert Safferman, "but these few particles can cause a whole lot of mischief." Safferman and other researchers at EPA's Environmental Monitoring and Support Laboratory in Cincinnati, Ohio, have just presented a procedure whereby viruses can be concentrated to make further testing possible. Using advanced filters and straightforward techniques, this method can concentrate the viruses present in a 100-gallon sample into less than one-half cup. The half cup of concentrate can then be placed into cell cultures designed to detect the presence of human intestinal viruses.

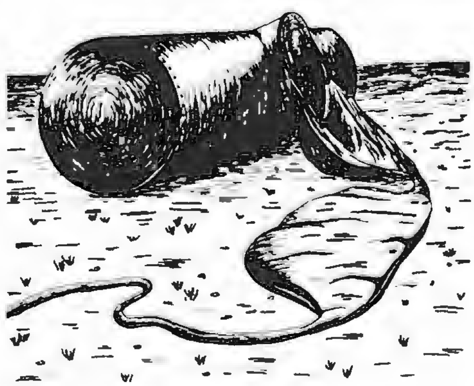
The advantage of this method is that it can be used under field conditions or in minimally equipped bacteriology laboratories to concentrate viruses from large volumes of water. The concentrates can then be shipped to an appropriately equipped virological testing facility for cell culturing. "This is the first time that state and local laboratories have had standardized, step-by-step procedures to detect viruses in drinking water," states Safferman. The procedures have been published as the *U.S. EPA Manual of Methods for Virology*, which is available from EPA's Center for Environmental Research Information in Cincinnati.

In the bag...

A major problem in both spills and clean-up operations involving hazardous liquids is the lack of a quick and inexpensive way to keep spills from spreading. As noted by Mike Royer of EPA's Municipal Environmental Research Laboratory in Cincinnati, Ohio, "if you can contain a spill where it's spilling, you avoid a much bigger — and more expensive — cleanup operation."

Investigators working for the laboratory's Edison, New Jersey facility examined a variety of methods to capture and contain spilling hazardous liquids. Although novel methods such as coating the ground with an impervious polymer layer were explored, the most promising approach was also the simplest. This involved creating a large, chemically resistant bag to contain the liquid at the point of the spill. This lightweight (20 pounds) disposable bag includes a drip apron to catch spills and a built-in drainage hose for removing captured liquids.

In response to a very positive reaction from the spill control community, EPA researchers are having six prototype 1,000-gallon bags created. The bags, which should cost less than $200 each if mass produced, will be given to organizations such as fire departments and emergency response units for evaluation. There are already more organizations interested than there are bags to test. "If the response of the folks on the front lines is positive," noted Royer, "we would expect private manufacturers to pick up the ball." Preliminary results from the evaluation should be available by late summer.



Sketch of a large bag designed to contain a pollution spill. The bag is being developed as a cleanup device by the Edison, New Jersey facility of EPA's Municipal Environmental Research Laboratory.

Like a sludge brickhouse

Many cities are having increasing difficulty disposing of the sludge left over from sewage treatment. Recently a researcher from Purdue, supported by the National Science Foundation, discovered a potential new use for the sludge. He worked with a Maryland brick maker to manufacture 500,000 bricks with sewage sludge in place of the water and sawdust normally used. The sludge made

Bricks made of about 50 percent sewage sludge were used to build this covered picnic shelter in Brighton Dam Park near Washington, D.C.

up approximately half of the brick. The bricks were used to build a covered picnic shelter in a park near Washington, D.C.

Although the kiln firing temperatures (2,000°F) destroy any organic matter, there is some concern with regard to the fate of the heavy metals present in the original sludge. To assure that the sludgebrick process does not release harmful amounts of these heavy metals, EPA's Municipal Environmental Research Laboratory in Cincinnati, Ohio is testing some of the bricks. In addition, researchers there intend to make some of the bricks under laboratory conditions to determine what happens to sludge components. Eventually, a significant portion of sludge may find a new identity as "biobrick."

L.A. haze

Using sophisticated airborne monitoring equipment, investigators from EPA's Environmental Monitoring Systems Laboratory in Las Vegas have provided a far more complete and detailed visualization of air pollution movement in southern California than was previously possible. The study was done using a laser-based remote sensing system, known as lidar, mounted in an airplane. EPA pioneered the use of lidar to measure pollutants.

In the study, a laser beam from the airplane is directed down at the air masses below and a very sensitive detector picks up the laser light scattered by pollutants in the air. The result is a "picture" of the relative concentrations of pollutants at different altitudes. "These studies have given us tremendous insight into the complexity of the situation," notes researcher Dr. James McElroy.

The studies have clearly shown how pollutant masses can form into several distinct layers before moving on. "On occasion, we've watched an air mass form over L.A., be drawn out to sea by night breezes and return inland the next morning far to the north toward Santa Barbara or south toward San Diego," says McElroy. Such layering and pollutant air mass movement had been hypothesized based upon knowledge of meteorology and piecemeal monitoring data. The recent lidar measurements have finally put the pieces together and provided researchers with important insights into the physical mechanisms which govern air mass movements.

It'll knock your SOx off

Sulfur oxides (SO_x) emitted to the atmosphere are a potential health hazard. They also account for more than half of the man-made compounds which contribute to acid rain. The main source of SO_x emissions east of the Mississippi is coal combustion. Over the past five years, approximately 120 coal-burning power plants have installed flue gas desulfurization (FGD) systems called "scrubbers" to reduce SO_x emissions. In these scrubbers, combustion exhaust gas comes into contact with a slurry of crushed limestone (or a similar substance) and water. The slurry reacts with the sulfur oxides in the flue gas and captures them as a sludge.

That scrubbers work is no longer in question. Neither is the fact that they are expensive and could be improved both in terms of sulfur dioxide capture rate and reliability. Several years ago, researchers from EPA's Industrial Environmental Research Laboratory at Research Triangle Park in North Carolina discovered that the addition of organic acids such as adipic acid (used as a food additive and in nylon manufacture) improved both the performance and efficiency of FGD scrubber systems.

To prove their point, the researchers are testing the addition of organic acids to commercial scrubber systems. Preliminary results from testing at the San Miguel Electric Cooperative in Jourdanton, Texas, have been encouraging. Significant improvements were noted in SO_2 removal, limestone use, generating capacity, waste handling and system operability. Further studies indicate that the utility could reduce FGD operating costs by more than $100,000 per year by converting to organic acid-enhanced operation. In another evaluation at City Utilities' Southwest Power Station in Springfield, Missouri, SO_2 removal was improved from 70 percent without to 90 percent with the addition of organic acids. Based upon these tests, City Utilities has decided to convert their FGD system to organic acid-enhanced operations as a method of allowing them to achieve regulatory compliance.

...and reduce gross sulfur loads

Ever since flue gas scrubbers were first introduced in this country, our researchers have been maintaining accurate records of their numbers, status and construction plans. Right now there are nearly 120 units in operation controlling 50,000 megawatts of generating capacity. Using this information, our researchers were able to estimate how sulfur dioxide emissions could be reduced through the widespread use of organic acid additives (see story above). Their findings are impressive. They estimate that the use of organic acid additives in those scrubbers which are either in operation or under construction would reduce SO_2 emissions by approximately 930,000 tons per year. Such a shift could reduce total U.S. sulfur dioxide emissions (approximately 24 million tons per year) by approximately four percent.

Continued to next page

City Utilities' Southwest Power Station in Springfield, Mo., with flue gas scrubber whose effectiveness is increased by the addition of organic acids. Scrubber structure is at base of smokestack.

Science Highlights:

Oh say can you see?

Regardless of what the song says, on a clear day you can't see forever. In fact, the theoretical limit to visibility through "pure" air is just over 200 miles (320 km) at sea level. This fact is apparent in western states where magnificant vistas which sometimes approach this theoretical maximum are a natural heritage. Recent research by EPA's Environmental Monitoring Systems Laboratory in Las Vegas has shed new light on the causes of visibility impairment in the area which includes many of our most spectacular national parks.

The EPA, along with the National Park Service and several other Federal and state agencies, has conducted extensive visibility monitoring and analysis studies in the region for more than four years. These studies are beginning to yield definitive results. "We have demonstrated very clear seasonal trends," says program manager Robert Snelling, "and a definite decrease in visibility with time over the four years of the study."

In addition to overall trends, the study has shown that pollution from sources hundreds of miles away often impairs visibility. Analysis of air mass trajectories and trace elements implicates three major regional sources — industrial and urban areas in southern California and along the coast of the Gulf of Mexico, and copper smelters in southern Arizona.

"It doesn't take much pollution to dramatically reduce visibility," notes Snelling. "The cleaner the air, the greater the impact of a little pollution." Analysis of the composition of the fine particles in the study region showed that 38 percent are sulfates. The only major source of the sulfates is regional transport from the sources mentioned above. An additional 37 percent of the particles are light elements including nitrates and carbonaceous particles which may also hail from far away. The remaining 23 percent of the particles are suspended soils. The bottom line of these studies is that between 60 percent and 75 percent total visibility impact in the west is due to regional transport of pollutants.

A 1,500-foot-deep chasm winds for more than five miles, carved by the San Juan River in southeastern Utah. The long-distance visibility in the scene is typical in a region that has been renowned for its clean air.

Eavesdropping on the underground

Underground injection wells are common in many areas. Texas alone has almost 50,000 injection wells for secondary oil recovery and brine disposal and 30,000 more for solution mining. During oilfield secondary recovery operations, wells often inject brine at depths of 3,000 to 5,000 feet — presumably safely below aquifers which might be used as sources of drinking water. Unfortunately, the casings of many older wells have corroded or the grout which seals casings has cracked. This allows the upward leakage of injected brine and other fluids.

Until now, contamination from leaking injection wells at depths of 100 feet or more has been impossible to detect without drilling expensive monitoring wells. In cooperation with the U.S. Geological Survey, researchers from EPA's Environmental Monitoring Systems Laboratory in Las Vegas have investigated advanced techniques for detecting and mapping leaking brine injection wells in Osage County, Okla.

"Preliminary results are very encouraging," according to EPA researcher Ron Evans, "It would seem that saltwater contaminant plumes may be detected at depths of from 100 feet to as much as 1,000 feet below the surface." The technique used is adapted from mineral exploration technology. Called "time domain electromagnetic induction," it involves inducing transient electrical currents deep within the earth and measuring the rates at which these currents decay. As the currents re-radiate energy, major conductive masses such as salt water plumes reveal themselves by influencing the rates of decay. "Now that we know that it can work," notes Evans, "we will focus on developing techniques to allow investigators to correctly interpret the data that these instruments produce." ☐

Science and the EPA Science Advisory Board

Dr. Norton Nelson, center, chairman of the Executive Committee of EPA's Science Advisory Board, meets with Administrator William Ruckelshaus and Terry F. Yosie, staff director of the Board.

By Dr. Norton Nelson
Chairman, Executive Committee Science Advisory Board

To say that sound regulation depends on good science may come through as a statement of the obvious; it also happens to be correct. It is widely agreed that where there is a basis for concern, the public supports appropriate regulation insuring good health and protection of the environment. In turn, those who are regulated, for example industry, have repeatedly taken the position that their concern is chiefly the soundness of the technological and scientific basis on which regulation is undertaken rather than a difference in objectives. Industry is staffed by managers, by technicians and scientists with roughly the same objectives as the rest of their fellow citizens; one should credit them with motives shared by the general public, namely, to control adverse exposures to prevent health damage and to maintain the quality of our environment.

The science that can and should go into regulation comes from many sources, from within the regulatory agency, from other federal institutions such as the National Institutes of Health, from universities and independent research enterprises, and from industry itself.

There has been a legitimate debate as to the ability of a regulatory agency to conduct research for its own regulatory needs. There is a predictable limitation on research in a regulatory agency arising from inevitable conflict between short term needs and longer term goals. In the operation of the regulatory agency, today's crisis is likely to overwhelm a prudent concern for long term research programs. On that basis, resources tend to be shifted to immediate firefighting requirements, always with the possibility that the longer term research will be sacrificed.

This conflict is not insurmountable but the conflict is real; failure to recognize it is to run the danger of slipping into erosion of longer term research. The solution depends entirely on the success of management in protecting the longer range objectives of the agency.

On the other hand, there are very good reasons why research responsive to regulation should be conducted within the regulatory agency; the agency is in

---

Dr. Nelson was appointed in January by the Administrator as Chairman of the Science Advisory Board's Executive Committee. He is a professor of environmental medicine at the Institute of Environmental Medicine, New York University Medical Center. Dr. Nelson, who has a broad background in environmental health and risk assessment, has previously served on committees of the Science Advisory Board as well as other federal scientific advisory committees.

the best position to determine its own needs. Constant oversight, however, is required to insure continuity of long range objectives as well as to insure that the science remains independent of perceived regulatory pressures.

As noted above, it is not supposed that all of the research supportive of health and environmental control comes from the regulatory agencies.Indeed, only a modest fraction is produced in-house. Much of the needed information, new as well as old, has been and is being developed in universities, research institutes and in some degree within industry. It is most unfortunate that at the very time the research budget of EPA was being severely reduced, federal support of extramural research resources was also, in many instances, reduced. At best, it has barely stayed abreast of inflation.Time and talent have been lost in the last few years in failing to maintain the needed research base supportive of EPA's objectives.

The new EPA management is clearly making a determined effort to improve the budget for research support both in-house and extramurally. A balanced science program supportive of EPA's objectives cannot possibly be accomplished with its own resources alone. It will be dependent very much on the building of linkages to the academic community and to independent research agencies and, indeed, to industry.

It is my perception that the bringing together a number of years ago of the predecessor units of EPA had the effect in some instances of interrupting a well working pattern of scientific rapport within the academic community for a number of the constituent programs of EPA. The lost ground has never been totally regained and EPA needs now to redouble its efforts to rebuild those bridges through a series of moves: conferences, scientist exchanges, increased extramural support and an enhanced program of long-term university research centers.

The Health Effects Institute which brings industrial and EPA money together to support research relevant to EPA is a useful model for expansion in other directions going beyond air pollution and its health effects.

There are, in addition, opportunities for EPA to achieve fuller cooperation with other federal research resources such as the National Institutes of Health, the Centers for Disease Control, the Food and Drug Administration, the National Center for Toxicological Research, and still others. Some advances in developing such cooperation had been made in an earlier time; such linkages should be resumed and intensely expanded.

It is my view that the Science Advisory Board in the past has allowed itself too frequently to become involved in what may be overly detailed editorial review of staff papers. Meticulous scientific review of such EPA products as the Criteria Documents which support the national ambient air quality standards is, of course, extremely important and indispensable. It is important that these be scientifically sound and represent the best scientific judgment.

I would hope, however, that ways can be found to expedite such reviews and minimize the purely editorial examination of such documents. Less attention may have been given to final documents prepared for regulatory action. More attention to these papers would bring the very high talents of the Science Advisory Board closer to the ultimate "action" in terms of regulation. In this way, the SAB would be giving attention not only to the initial survey of science, but also to that winnowing and selection of scientific judgments and principles which enter into the final regulatory position. I believe this change in emphasis is desirable and possible.

The information required by EPA for regulatory purposes is very diverse, covering the entire biosphere, human and non-human as well as inanimate systems. In addition to this broad scope there is a great deal of interaction and linkage in the needed assembly of information for wise regulation. It includes such issues as transport through water, ground water, soils and air. During this transport, materials may be altered and increased or decreased in toxicity and transportability. These chemical changes can be complex and decisive for the qualitative nature of the chemical and the intensity of exposure of the target. Once the chemicals reach the target organisms, be they human or nonhuman, the nature of the biological interactions needs to be understood. A next step in the linkage has to do with the need to quantitate the responses.

What this adds up to is that much of EPA's research needs for regulation may require the understanding of hydrology, meteorology, reaction within air, within water, within soils, biochemical interactions, statistical analysis, and mathematical modeling of the interrelationships of these components.

This suggests that regulatory research will often require a set of related inquiries using many different disciplines. Thus, careful and thoughtful planning of the interactive components in these steps from source to adverse outcome will be required. Examples of such comprehensive planning are rare: one that springs first to mind is the extensive and rewarding effort in the study on diesel exhaust in order to determine its probable human impact.

This concept implies that appropriately broad research planning should be employed wherever needed in EPA. The Science Advisory Board could play a role here through the development of *ad hoc* subgroups working with EPA staff in developing broad strategies which would bring together these various interrelated disciplines. This approach is worthy of exploration; it would expand the initiatory role of the Board in research planning. I believe, on the one hand, broader planning of this sort needs greater use within the agency and I think it well worth the effort to explore whether a useful contribution along these lines can come from the diverse talents within the Science Advisory Board.

The present EPA administration has properly placed a very high priority on qualitative and quantitative risk assessment. Currently, the distinction between risk assessment and risk management has been rather well defined by the recent National Academy report. Risk assessment falls clearly within the purview of science and technology; thus, the technology of risk assessment is clearly in the domain of the Science Advisory Board. To go beyond this into risk management or the balancing of cost and benefits is, however, to invade the area of the Administrator who is by Congress defined as a surrogate for the entire citizenry representing all constituencies and all interests, general and special. As such, he is clearly responsible for making the decision which balances benefits and societal costs.

On the other hand, such a separation, though easily stated, sometimes is difficult to maintain. There is an area between assessment and management which is blurred and in which the scientists can legitimately participate and may sometimes inadvertently overstep. The basic objective here, I believe, is to recognize that such separation is desirable and that a full awareness of the separation should be kept in mind at each stage of the risk assessment process.

The Science Advisory Board has over the years been an important resource to EPA and a very solid monitor of its research programs and research policies. The Administrator and the Deputy Administrator have both clearly expressed themselves as wishing to make fuller use of the Board and to look to it even more than in the past for its full participation in science and science policies relating to EPA's control and regulatory responsibilities. We are confident the Board can meet these expectations. □

Testing the Potential of Cleanup Technology

By Susan Tejada

EPA engineering laboratories are evaluating a variety of new technologies. The labs are part of EPA's Office of Research and Development (ORD). In many cases, they introduce technology with commercial potential, to be developed and marketed by the private sector.

In some instances, ORD assesses the potential of a technology already in use overseas, for use in the United States. Such was the case with the swirl separator and regulator for sewers, which was developed in England. ORD modified the original design, and evaluated its use for combined sewer overflow control and sewage degritting in this country.

ORD also conducts research on new technology in-house. Use of organic acid additives to improve limestone scrubber performance was conceived of and tested by agency lab staff.

ORD funds technology research by private sector institutions, and assesses the practical application of technology that has already been developed by industry but is not in widespread use. This was the case with pressure sewers, discussed in more detail below.

EPA sometimes becomes involved in development of a specific technology when industry has little incentive to do so. For example, waste treatment is not an especially profitable area for waste generators. Consulting engineers who work for generators tend to emphasize refinement of proven waste treatment processes for their plants rather than risk funds on untested ideas. Even manufacturers of pollution control equipment tend to improve or expand their existing lines rather than work on innovative but initially expensive high technology with unknown applications. Many plants are simply too small to afford research and development efforts. In situations like these, EPA's Office of Research and Development has a role to play in evaluating the feasibility and cost effectiveness of new technologies.

This article looks at three EPA program areas — air, water, and hazardous wastes — where the Office of Research and Development has tested new technologies. The examples chosen are mainly of time-tested technologies that have been around long enough to have been picked up, adapted, and marketed by private industry.

Hazardous Waste

EPA's Municipal Environmental Research Laboratory facility in Edison, N.J., tests and evaluates prototype equipment for hazardous material spill response and control. Technologies now being evaluated include mobile versions of various kinds of waste treatment systems: a mobile incineration system, a mobile reverse osmosis treatment system, a mobile system for detoxification and regeneration of spent activated carbon, and a mobile system for extracting spilled hazardous materials from soil.

The two examples cited below, having withstood the test of time, have been adapted and marketed by industry.

Acoustic emission monitoring device

There are as many as 500,000 diked areas in the United States containing potentially hazardous wastes. These range from small waste ponds at chemical manufacturing plants to mile-square tailings lagoons at mines, smelters, and phosphoric acid plants. Many of these impoundments are unstable. Under slight stress from a heavy rain, for example, they can collapse and spill their contents. Some of the more notorious such incidents have resulted in a large fish kill in Norris Lake, Tennessee and kepone contamination of the James River in Virginia.

Soils under stress emit sounds. To study this phenomenon, EPA awarded a grant to Drexel University. Field testing carried out by EPA and Drexel scientists verified that unstable soil produces large quantities of acoustic emissions and that, conversely, stable soil produces low or nonexistent acoustic emissions.

Based on the results of their field testing, the scientists developed an acoustic emission monitoring device to determine the stability of earthen dams. The device consists of metal waveguides, an accelerometer, an amplifier, and a display system counter. The electronic components are battery operated. Acoustical emissions are transmitted to the surface of the soil through waveguides, or rods, driven into the walls of the impoundment. These sounds are converted to electrical analogues, amplified, and recorded for analysis. A

An acoustic emission monitoring device used to pick up sounds from soils under stress, helping to determine the stability of dams that might collapse and spill toxic contents.

counter responds to signals above a preset threshold level, and records the rate of sound emissions.

The acoustic emission monitoring device is portable and inexpensive. It can be operated either periodically or continuously, and requires little maintenance.

Since their development, acoustic emission devices have been installed across the country, at dams ranging in length from 20 feet to 6 miles, and have proven successful. For example, they provided early warning of the threatened collapse of an industrial dike and of an abandoned lagoon at a chemical waste disposal facility. In each case danger was detected in time to shore up the walls and prevent collapse.

In 1977, *Industrial Research* magazine presented its IR-100 award jointly to EPA and Drexel University for development of the acoustic emission monitoring device. Citing use of acoustic emission monitoring by chemical manufacturers and construction companies, the award called the "Earth Dam Spill Alert Device" one of the year's most significant contributions in industrial research.

In 1979 EPA's Industrial Environmental Research Laboratory published a capsule report on acoustic monitoring as part of its technology transfer program. Today several manufacturers sell packaged systems for acoustic emission monitoring of earth structures.

Mobile physical-chemical treatment system

In 1971, EPA contracted with a private company to build a trailer-mounted system of wastewater treatment for test and evaluation. In this system, as modified by EPA lab staff, contaminated water is pumped into a settling tank for flocculation and sedimentation. The clarified fluid then passes through filters and enters carbon adsorption columns. Sludge is removed from the sedimentation tanks and stored for disposal. Any step in the process can be bypassed, and additional storage tanks can be provided for filter backwashing or temporary storage of unprocessed materials.

EPA maintains two mobile treatment trailers, a larger one with three filters and carbon columns, and a smaller one with one filter and carbon column. EPA has used the trailers at more than 50 clean-up operations during the past several years. For example, when pesticides were washed into a tributary to the Millstone River, a public water supply for Allentown, N.J., more than 7.6 million liters of the contaminated water were processed through the trailer. In another incident, PCBs were spilled into the Duwamish Waterway in Seattle, Wash. Divers in protective suits first pumped water and spilled material through pre-settling tanks. Then the filters and carbon adsorption columns of the trailer were used to further decontaminate the water.

In a 1978 report published in the *Journal of the Water Pollution Control Federation*, EPA scientist Dr. Joseph Lafornara observed that, in six cases studied, use of the trailer had achieved greater than 90 percent removal from water for 21 toxic materials.

EPA published a report on the development of the mobile physical-chemical treatment system as part of the Environmental Protection Technology Series. Physical-chemical treatment systems have since been developed, or are now being developed, by many companies, including Calgon Corporation, OH Materials, ENSCO Group, and IT Corporation.

A mobile trailer-mounted system developed under contract from EPA to treat water contaminated by spills and other pollution incidents.

Phosphorus removal

Eutrophication is the slow aging process in which a lake evolves into a marsh and eventually disappears. During eutrophication a lake is choked by plant life. Human activities such as wastewater disposal that add nutrients to a lake can speed up the process.

The Great Lakes are particularly susceptible to eutrophication caused by the high phosphorus content of wastewater from adjacent treatment plants. The phosphorus comes from agricultural runoff, detergents, and human and industrial wastes.

Under a treaty agreement between the U.S. and Canada, amended in 1972, eutrophication of the Great Lakes was to be brought under control. Yet the municipalities concerned did not have the research capability to come up with a solution, and industry did not have a profit incentive.

EPA originated a small in-house pilot scale project to test the feasibility of adding metallic salts to treatment systems to control phosphorus. The salts combine with phosphates in the wastewater to form an insoluble compound which can be removed by gravity sedimentation. A patent on the process was issued to the U.S. government for unrestricted use by any municipality. EPA's Municipal Environmental Research Lab in Cincinnati subsequently conducted full scale pilot testing at 20 treatment plants.

Without the addition of metallic salts, treatment plants had had about a 10 percent phosphorus removal efficiency. With metallic salts, the efficiency rate increased to about 90 percent.

The government-patented technique of phosphorus removal has been so successful that it is now being used at about 1,500 facilities worldwide. This includes more than 560 facilities in the U.S. Although the great majority of these plants — about 400 — are located in the Great Lakes area, the largest one is the Blue Plains Wastewater Treatment Plant in Washington, D.C. A 1982 survey estimated that, by the year 2,000, more than 1,200 facilities in the U.S. will be using this process.

EPA continues to have an active role in providing technical assistance to treatment facilities seeking to use this technique.

Pressure sewers

Conventional sewers operate by gravity; wastewater is transported through sloping pipes underground. In densely populated areas, conventional sewers are cost-effective because the amount of sewer required per person is reasonable. But in less populated areas, where houses are spread out, the amount of conventional sewer required per person is greater, and so is the cost.

As a result, on-site systems — usually septic tank-soil absorption systems — are the primary form of wastewater treatment and disposal in rural areas. Unfortunately these systems sometimes fail because of unsuitable soil, faulty design and construction, or owner negligence.

EPA initiated a study through the American Society of Civil Engineers (ASCE) to find an alternative to conventional sewers. One of the alternatives studied was a pump-grinder unit that could be used for pressure sewers. Because it relies on pump pressure instead of gravity to move wastes, and because it uses small diameter plastic pipe, a pressure sewer system can follow the contours of the ground, going uphill or downhill. It does not require deep trenches, so installation costs are less than those for a conventional sewer system. Also, because they run intermittently on low horsepower and are easily repaired, pressure sewer pumps have nominal operating and maintenance costs.

The ASCE study determined that use of a pump-grinder unit for pumping ground sewage through small diameter pipes was feasible. EPA then funded four studies of pressure sewer systems in Albany, N.Y., Phoenixville, Pa., Grandview Lake, Ind., and Bend, Ore. The last of these studies was completed in 1978. The research showed the viability of pressure sewers in a variety of situations: one house/one pump in Albany, multiple family dwellings on a single pump in Phoenixville, and a much larger, lakeside system in Grandview Lake. The Bend project also looked at another type of pump, a septic tank effluent pump. In Grandview Lake, where the cost of installing conventional sewerage had been estimated at $10,000 per home because of unfavorable terrain, the installed cost of pressure sewerage was only $1,000-$1,500 per home.

As a result of these studies, EPA produced a technology transfer document with engineering design parameters for pressure sewers that are used today. This document was the first centralized compilation of information on pressure sewers.

Pressure sewer technology is now in use at more than 200 installations in the United States. Pressure sewers have saved small communities from 10 to 90 percent of the cost of conventional sewers. From late 1978 to mid-1982, EPA funded 146 small community wastewater collection systems under the construction grants program. About two-thirds of these were pressure sewer systems.

The Blue Plains Wastewater Treatment Plant in Washington, D.C. This is the largest such facility in the U.S. using phosphorus removal methods originated by EPA.

Air

Low NO_x burners

The low NO_x (nitrogen oxides) burner program is an EPA-sponsored effort to conduct research into combustion systems that reduce nitrogen oxide emissions from coal-fired boilers.

Existing combustion technology did not appear capable of meeting projected nitrogen oxides emission goals. EPA tried to upgrade that technology, and to demonstrate its technical feasibility and reliability to boiler manufacturer and utility companies.

In the low NO_x burners developed by EPA's Industrial Environmental Research Lab in North Carolina, combustion air is added in stages. This insures, early in the combustion process, a fuel rich zone which tends to reduce production of nitrogen oxides. The goals of the low NO_x burner program are to reduce nitrogen oxides by 60-70 percent over uncontrolled levels for retrofit applications, and by 70-80 percent for new applications.

A retrofitted wall-fired industrial boiler at Western Illinois Power Company in Pearl, Ill., and a tangentially-fired utility boiler at Utah Power and Light Company in Castledale, Utah, were field-evaluated. In both cases, nitrogen oxide emissions were successfully controlled with no adverse impact on other combustion-related pollutants or on unit performance. The companies which participated in these field evaluations will be in a position to commercialize the technology.

Work on low NO_x burners has led EPA to sponsor research on another emission control technology for coal-fired boilers: limestone injection in multistaged burners, or LIMB. The agency is sponsoring research, pilot scale testing, process analysis, and field evaluations.

Unlike flue gas desulfurization, which removes only sulfur oxides, and low NO_x burners, which remove only nitrogen oxides, LIMB will simultaneously remove both sulfur and nitrogen oxides from boiler flue gases. The LIMB concept uses low NO_x burners to introduce limestone or other sorbents in the boiler combustion zone for the sulfur oxide removal.

If LIMB meets its technical objectives, it would be unique among commercial technologies in achieving high levels of sulfur oxide removal at relatively low costs, lower than the costs of flue gas desulfurization. An extra bonus, of course, would be its ability to substantially reduce nitrogen oxide levels. LIMB technology may also prove to be particularly important in control of acid rain.

* * * *

The Office of Research and Development projects described in this article have been around long enough so that the operating problems have been resolved and commercialization has taken place. In years to come, work being done in ORD labs will be time-tested as these projects have been, and present day research should result in many more private industry applications five or six years from now. □

Cutting Costs while Cleaning Air

Painted truck parts moving into a drying oven at the Mack Trucks plant in Allentown, Pa. Computer-controlled oven improves the control of volatile organic air pollution and cuts energy costs.

by Carl Gagliardi

Ask anyone about the way the federal government and industry are supposed to work out their environmental problems and you will likely hear this conventional scenario. Congress passes a law setting pollution standards for an industry. EPA writes the regulations for the law, calling for the industry to meet the standards within a certain time limit. The industry protests, saying it cannot meet the standards, or it cannot afford the necessary technology, or both. EPA replies that they must meet them anyway.

Like most conventional wisdom, this scenario is sometimes wrong, and EPA is showing that it doesn't have to work this way. The agency and industry have been finding ways of helping each other. In addition to setting standards, the agency is helping industries find the ways to meet them.

A perfect example of the agency's commitment to helping industry meet standards mandated by Congress is a program to help the painting and chemical coating industry develop the technology to meet provisions of the Clean Air Act. The agency's Office of Research and Development, in a joint effort with the Department of Energy and the Chemical Coaters Association (CCA), developed a system for the coating industry that not only helps them meet the clean air standards but also saves them money in the process.

In the process of painting and coating metal and other surfaces, these industries release volatile organic compounds (VOCs) into the air. VOCs are a class of hydrocarbons that react with sunlight to produce ozone, a harmful air pollutant. Some VOCs are toxic in themselves. Because so many manufactured products are painted with solvents that produce VOCs during the baking process, the coating industries are one of the leading contributors to industrial air pollution. Automobiles, appliances, furniture, plastics, aluminum siding and hundreds of similar products are coated in ovens that release VOCs in dangerous quantities. This industry generates more than 8.5 million tons of VOCs a year. According to EPA, these emissions are considered to be one of the biggest contributors to the smog problem in most major U.S. cities.

Under sections of the Clean Air Act, EPA is responsible for curbing VOCs. But the agency must also take into account the financial ability of industry to absorb the cost of cutting emissions or developing equipment to reduce them. Most coating companies are small operations with modest financial resources that cannot afford the enormous cost of complying with the VOC standards set down under Sections 111 and 112 of the Act. The metal finishing industry, which typically uses VOC coatings or cleaning agents in their processes, is made up of over 80,000 plants. More than 40,000 of them employ fewer than 20 people.

The cost of controlling VOC emissions, particularly difficult for small plants, was the main obstacle to industry acceptance of the regulations. Some of the existing emission control processes would have cost the industry one to two times the cost of coating the product. A less expensive method of controlling emissions was needed.

So, in 1979, EPA and the U.S. Department of Energy became partners with the Chemical Coaters Association in a venture to develop the technology for the coating industry to reduce VOC emissions without driving up the cost of painting manufactured goods. The project officials contacted over 75 painting equipment users, vendors and designers to choose the best evaluation sites and to get a better understanding of what was involved in the coating process. They formed a committee of government and industry officials to give the project technical direction, and in 1981 they picked the Mack Trucks plant in Allentown, Pa., as the host site to evaluate the technology for controlling VOCs.

Coating and painting plants that release large amounts of VOCs do so because they take more air into the oven during the baking process than is necessary. Certain solvents used in paints and coatings are extremely explosive in vapor form. So the coating operator must draw a large volume of air into the oven to keep the density of the vapor from reaching a point where it would ignite. The amount of air needed depends on the lower explosive limit (LEL) of the solvent. The lower explosive limit is the least amount of solvent that makes an atmosphere explosive. Coaters have been operating the ovens with greater amounts of excess air than is needed to keep the oven environment safe, sometimes as much as 50 to 100 times greater.

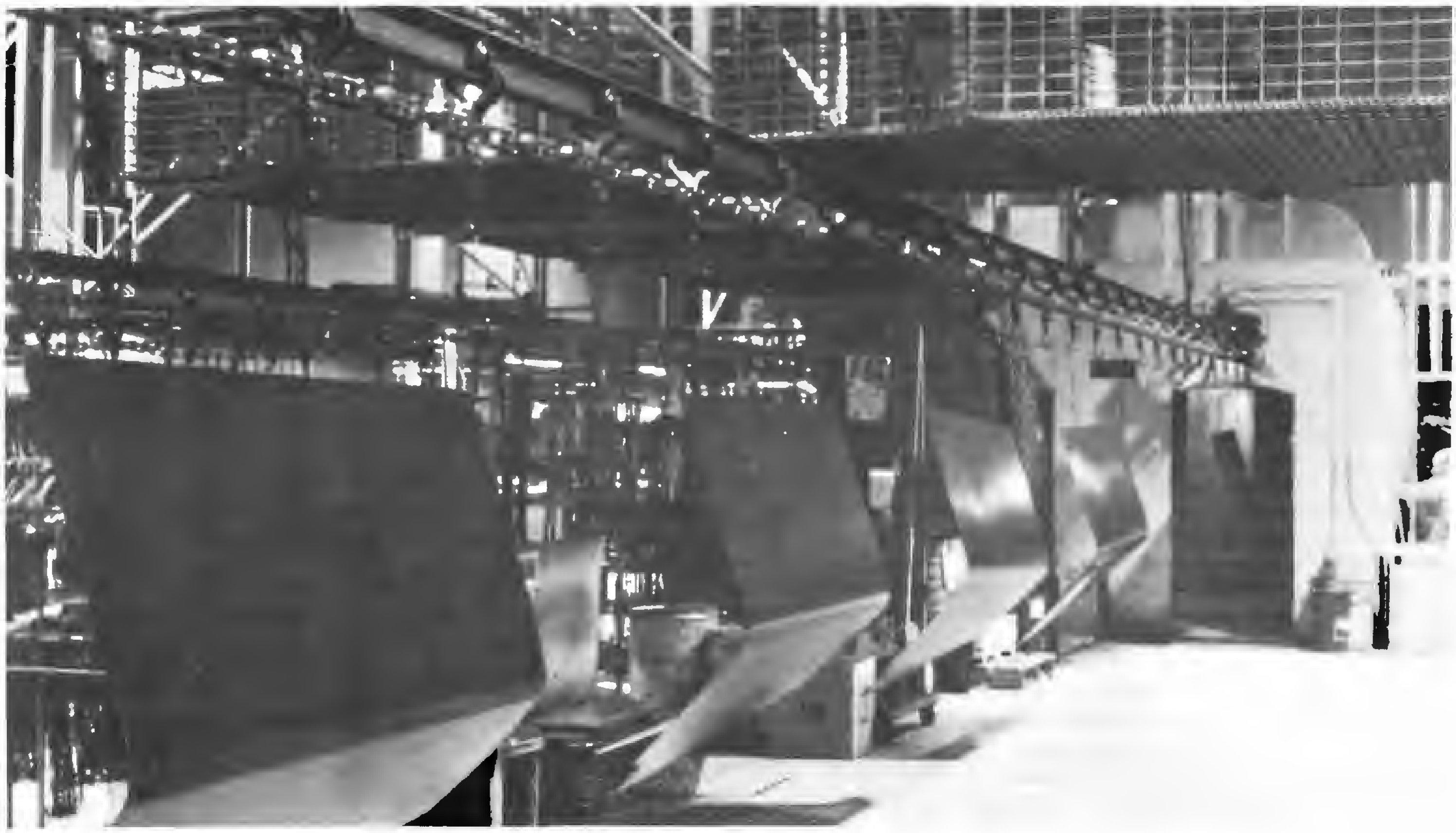
The coating industry traditionally has regarded operating the ovens at 25 percent of the LEL as required for safety, but it has been found that the oven can be operated with less air, or 50 percent of the LEL. It was the job of the EPA project to demonstrate that industry could bake the coatings at higher solvent concentrations approaching the 50 percent LEL.

The project officials developed a computer system to allow the operation of the oven at lower air flows and higher solvent concentrations. With LEL monitors installed at certain points in the oven, the microprocessor receives readings which signal that the solvent concentrations have reached the safe level. It then automatically activates various control surfaces—like dampers, fans and coating applicators—which set the oven atmosphere at the most economical level. The microprocessor permits instantaneous changes in concentrations, so the oven atmosphere remains relatively stable.

Because the computer-guided system requires less air, VOCs are released at much lower levels. And because more

---

Carl Gagliardi is a Press Officer in the EPA Office of Public Affairs.



energy is required to heat excess air to the incineration temperature, the microprocessor-directed system is more fuel efficient than the conventional system to control VOC emissions. Using less energy, of course, means the industry operates its ovens at less cost.

Before Mack Trucks was chosen as the demonstration site for the project, the development and engineering work was completed by Centec Process Systems. Although the system was developed entirely from off-the-shelf equipment, computers had never been used for this purpose. Centec programmed the computer and adapted it to work with the ovens. EPA's engineers managed the system and defined its performance requirements.

The development of the technology to demonstrate the advantage of reducing the amount of air needed during the baking process was considered too costly by the industry because, among other reasons, any coating company enterprising enough to absorb the cost of developing it would not be able to patent it because the process, although new, is considered public information.

The project members put their findings to the test. They found by using the microprocessor system, the emissions rate dropped significantly, while operations could be carried on at a safe level. In energy use alone, a typical plant would save more than $100,000 a year.

Charles Darvin, an EPA physical scientist at the agency's Industrial Environmental Research Laboratory in Cincinnati and the project director, has shown that if this system were installed in only 600 of the estimated 13,000 metal finishing ovens, the savings in energy costs and VOC emissions nationally would be enormous. According to his figures, industry could save an estimated 7 million barrels of oil a year. At $29 a barrel, this would amount to a savings of $200 million each year.

Not only does the computer system reduce VOC emissions but, because it does so at a lower cost, it gives EPA the ability to set more stringent standards. Under Section 111 of the Clean Air Act, EPA must take the cost to the industry into account when it establishes New Source Performance Standards (NSPS) for a pollutant. In this case, the agency has the option of setting tougher standards because it can prove that the costs to the industry will not be prohibitive. EPA can show, in fact, that the microprocessor will even save industry money.

Once the project team evaluated the system, their next step was to sell it to the industry. Darvin picked the "toughest peer review committee I could find." The committee consisted of Fred Jensen of Jensen Oven Co., Rolf Westen of Price-Westen & Co. and A.C. Walberg of Arvid C. Walberg & Co. In June 1983, that committee endorsed the project, saying the microprocessor system "is a very viable project."

"It provides excellent air pollution control with very good economic returns on a large capital investment," the report said. "The project would never have been carried out by the private sector. The funding by the EPA made the project possible, and the data obtained from the project is now public information."

Joe Schrantz, executive editor of *Industrial Finishing*, a trade magazine, observed the Mack Trucks oven microprocessor system and concluded that the project "proves for the first time that an industrial finishing oven's solvent vapor concentration can be controlled automatically by a computer. Controlling vapor concentration means less dilution air is required, thus dramatically reducing the amount of oven air that has to be heated."

Mack Trucks and Prior Coated Metals, Inc., already have begun using the equipment in their daily operations, with seven more companies preparing to install it. □

Assessing Health and Environmental Risks

by Dr. Elizabeth L. Anderson

The Office of Health and Environmental Assessment, located in the EPA Office of Research and Development, is primarily responsible for providing EPA with a central capability for evaluating information on the health effects of toxic pollutants and for ensuring the consistency and technical competence in the agency's risk assessment work. This office prepares a variety of documents including: air and water criteria documents; health, risk, and exposure assessments; and guidance and methodology documents used in assessing the risk of exposure to hazardous pollutants. This office consists of five units: the Carcinogen Assessment Group, the Exposure Assessment Group, and the Reproductive Effects Assessment Group, located in EPA headquarters, and two Environmental Criteria and Assessment Offices located in Cincinnati, Oh. and Research Triangle Park, N.C.

As one stage of its document development and scientific review process, the Office of Health and Environmental Assessment convenes workshops with scientific experts to peer review its health assessment and criteria documents. Through announcements in the *Federal Register*, the public is invited to comment on the revised, or external review drafts. Final versions of health assessment and criteria documents reflect the advice from the workshops and the public comments, and from EPA's Science Advisory Board, which meets in public sessions to review these health assessments.

Air quality criteria documents contain all of the latest scientific knowledge about an air pollutant and indicate the kind and extent of all identifiable effects on health and welfare. These documents are mandated by the Clean Air Act and, as directed by the Act, are reviewed at 5-year intervals. The Air Quality Criteria Documents form the health basis on which the Administrator relies in setting ambient air quality standards.

There are five air criteria pollutants: carbon monoxide, oxides of nitrogen, ozone and other photochemical oxidants, particulate matter and sulfur oxides, and lead. In 1983, an addendum to the carbon monoxide document was released for review as was the lead criteria document. In early 1984, the final criteria documents for oxides of nitrogen and particulate matter and sulfur oxides were published. The ozone criteria document is scheduled for public review in August 1984. These documents are prepared under the direction of the Environmental Criteria and Assessment Office in Research Triangle Park, N.C.

The emphasis in the water quality criteria documents is on the protection of aquatic life and human health. Thirteen ambient water quality criteria documents were updated in 1983 and the final water quality criteria document on dioxins was published in February 1984. Drinking water criteria documents are comprehensive evaluations which contain health effects criteria and recommended maximum contaminant levels (RMCLs) for chemicals in drinking water. Approximately 31 drinking water criteria documents have been completed or are underway at the present time. These include 1,1-dichloroethane, mercury, silver, 2,4-D, endrin, lindane, methoxychlor, toxaphene, and 2,4,5-TP. These documents are developed by the Environmental Criteria and Assessment Office in Cincinnati with input from EPA's Duluth laboratory (aquatic effects) and Carcinogen, Reproductive and Exposure Assessment Groups.

Health assessment documents provide evaluations of the known health data from all exposure routes and risk assessment information. The documents are widely used by the agency and, in particular, form the primary health basis for deciding whether certain substances should be listed as hazardous air pollutants. Final health assessment documents have been published on acrylonitrile, carbon tetrachloride, chlorofluorocarbon FC-113, coke oven emissions, inorganic arsenic, methyl chloroform, and toluene. Draft assessments have been made available for public review and comment on cadmium, chlorinated benzenes, chloroform, chromium, dioxins, epichlorohydrin, ethylene dichloride, ethylene oxide, hexachlorocyclopentadiene, manganese, methylene chloride, nickel, tetrachloroethylene, trichloroethylene, and vinylidene chloride.

Among the other chemical assessments underway or scheduled for initiation are mercury, beryllium, phosgene, chloroprene, acrolein, acetaldehyde, phenol, propylene oxide, copper, and 1,3-butadiene. Health assessment documents are developed in the Environmental Criteria and Assessment Offices, with chapters on carcinogenicity, mutagenicity, and reproductive effects prepared by the Carcinogen Assessment and Reproductive Effects Assessment Groups.

Examples of other assessment support provided are:

- Health and Environmental Effects Profiles are assessments of a chemical's toxicity and environmental fate that provide preliminary scientific judgments regarding a chemical's potential harmful effects to human and aquatic life, and the environment. These reviews serve as a basis for listing regulations under the Resource Conservation and Recovery Act. Approximately 90 of these profiles have been completed for the Office of Solid Waste.

- In support of Superfund, methodologies for deriving reportable quantities were developed and 244 reportable quantity documents based on chronic toxicity were prepared in 1983 by the Environmental Criteria and Assessment Offices in Cincinnati. Profiles for ranking carcinogenicity hazards for 192 chemicals will be provided to the program by the Carcinogen Assessment Group in the summer of 1984. These profiles summarize available carcinogenicity data and will serve as scientific input to rulemaking decisions to establish levels for reporting on hazardous substances.

- The evaluation of health risk of populations near hazardous waste sites considers the risks posed by the combined multi-route exposure to the chemical mixture. Brief preliminary evaluations of health risks due to waste

(Dr. Anderson is Director of the Office of Health and Environmental Assessment.)

Disposal site in the early 1970s in the Imperial Valley, near El Centro, Calif., for discarded pesticide containers. EPA is assessing the risks of wastes to people.

site releases or chemical spills are provided to the regional and program offices on request. These evaluations are prepared by the Environmental Criteria and Assessment Office in Cincinnati. In emergencies, the brief summary is communicated within two working days of the request. This quick response is made possible by the extensive use of the database known as "studies in toxicity applicable to risk assessment," which contains dose-response information by exposure group for each chemical listed. These data include species tested, route, exposure levels and duration, affected organs, severity of toxicity, and details on the specific effects observed. This database currently covers 160 chemicals and is being expanded to incorporate epidemiologic and pharmacokinetic information.

Exposure assessments are evaluations of human exposure occurring as a result of an industrial operation or the dumping of hazardous materials. Several assessments of dioxin-contaminated sites have been conducted by the Exposure Assessment Group during the past year in support of the agency's regulatory and enforcement programs. Some of the specific sites which have been assessed are the Shenandoah Horse Arena (dioxin) in Moscow Mills, Mo., and the ASARCO smelter (arsenic) in Tacoma, Wash. The Office of Health and Environmental Assessment also provides technical reviews of exposure assessments prepared by other EPA offices, and technical advice and guidance to these offices on conducting evaluations.

EPA uses the scientific knowledge concerning the effects of toxic pollutants to implement its statutory responsibilities. The Office of Health and Environmental Assessment plays an active role in providing advice and guidance to the EPA regulatory and enforcement offices because of the scientific knowledge accumulated during the course of its evaluations.

An example is the public hearings EPA recently held in Tacoma, Wash. on the proposed regulation of arsenic emissions from the ASARCO smelter. The purpose of these hearings was to solicit comments from concerned citizens and to explain the information the agency used to make the proposed regulations. The Office of Health and Environmental Assessment played an active role in these public meetings. The final regulatory decisions on inorganic arsenic will rely, for health information, on the office's assessment of the health effects associated with arsenic exposure.

The Administrator has adopted a two-step approach to the management of public health risk. The first step is risk assessment, or characterizing the nature and extent of the risk. The second step is risk management, or deciding what to do about the problem. The Office of Health and Environmental Assessment is concerned with risk assessment. This involves critical analysis of all available toxicological data on the environmental agent being evaluated, and estimates of human exposure.

Risk assessment answers two questions: how likely is an agent to be a toxic substance (the qualitative evaluation), and what is the magnitude of the risk of exposure to the agent (the quantitative evaluation)? Most of the experience to date is in the area of cancer risk assessment. EPA adopted an approach in 1976 to first determine the weight-of-evidence that an agent might be a human carcinogen, and, second, to determine the magnitude of the public health impact given current and projected exposure. Cancer risk assessments are prepared by the Carcinogen Assessment Group.

While there is no scientifically proven method for quantitatively estimating effects at low doses from human and animal cancer incidence data at high doses, the Office of Health and Environmental Assessment has adopted the use of a linear, non-threshold model in its quantitative risk assessments. The linear non-threshold model is regarded as having some biological plausibility and is based on the concept that cancer can be initiated by a single molecular event somewhere in a cell. Although there are major uncertainties in the extrapolation to low doses, the use of the linear model gives a plausible upper limit of risk which generally is a higher risk estimate than other models. However, other models would be considered if available data would warrant their use.

Because of the uncertainties in estimating cancer risk, the Carcinogen Assessment Group has several projects which are designed to better the risk assessment methodology. One project is being conducted in cooperation with the Department of Defense to identify and quantify the uncertainty in quantitative risk assessment. The objectives are: to identify and to express quantitative uncertainties that are involved in the process of risk estimation, excluding the uncertainties due to the low dose; to examine the impact of the different assumptions that are made in the risk estimate; to compare results calculated from human and animal data, including the identification of the assumptions that produce best correlation of risk estimates between humans and animals; and, to develop guidelines for presenting a range of risk estimates based on different but scientifically acceptable assumptions or the assumptions that have considerable backing in the scientific community.

The Deputy Administrator convened a toxics integration task force to examine ways for EPA to coordinate its policies and actions on toxic substances. One of the task force's principal areas of concern was assurance of technical quality and consistency in EPA's risk assessments. From the task force recommendations, the Deputy Administrator directed two activities in risk assessment, both of which will be chaired by the Office of Health and Environmental Assessment with participation by all of the EPA program offices.

The first of these will be to revise or develop guidelines for performing risk assessments. The guidelines, which cover six areas, are expected to be available during the summer of 1984. These are: carcinogenicity, mutagenicity, reproductive effects, systemic toxicants (other chronic effects), complex mixtures, and exposure assessment.

A risk assessment forum will also be established under the chairmanship of the Office of Health and Environmental Assessment. This forum will consist of senior scientists from each of the program offices and will oversee risk assessment in four ways:

- Review risk assessments upon referral from the program offices.

- Make recommendations for risk assessment procedures not covered by the original guidelines.

- Make recommendations on risk assessment issues of a procedural nature.

- Recommend revisions to the 1984 guidelines whenever such revisions appear to be necessary.

Suggestions for improving the scientific basis for risk assessment also are made by the staff as they perform their assessments. These are often made to strengthen the ability to make risk assessments in general, as well as for chemical-specific limitations. The Office of Health and Environmental Assessment has recently sponsored workshops to convene recognized experts in the field of mutagenicity and reproductive effects [teratogenicity and male and female sterility] and complex mixtures.

The workgroups focus on research approaches for improving the scientific foundation for risk assessment in specific, key problem areas. A forum of expert scientists is an efficient way to tap the current knowledge and to help identify approaches and research to improve the agency's ability to assess the potential risk of environmental agents.

For example, a symposium of international experts is being planned for March 25-28, 1985 at the Carnegie Institute of Washington, D. C. to discuss the topic of aneuploidy (an end point in mutagenesis) with regard to information on mechanisms of action, existing experimental test results, and the human aspects of the problem.

A human biomonitoring workshop was conducted in December 1982 because certain federal laws require balancing the consequences of mutagenic risks with the benefits provided by the use of chemical substances. This requires that risk be quantitatively assessed. Estimates of human genetic risk can be made indirectly based on data from animal experimentation and human somatic cells, but it is not feasible to estimate genetic risk directly based on data from human germ cells.

The indirect estimates are highly debated because of uncertainties about interspecies and interorgan extrapolations. Uncertainties in extrapolating from effects observed in animals at high experimental doses to effects likely to occur in humans at much lower environmental levels further complicate genetic risk assessment. The workgroup suggested that comparative studies be conducted to define the relationships between somatic cell and germ cell events and between experimental animals and humans. The work group also recommended that at least one high-risk human population be selected for study, such as cancer chemotherapy patients and their children, to compare them with experimental animal populations given the same drugs.

Such a study would show how predictive the animal model is for humans for the days tested. To be effective, such efforts will require a long-term coordination of activities among federal agencies, industrial laboratories, and the academic community. So far, EPA has held follow-up meetings with the National Cancer Institute, the American Red Cross, and the National Toxicology Program, as well as with other concerned offices. Relevant research has been initiated to address some of the problems and a follow-up workshop to identify an appropriate high-risk human population is being planned. Most workshop endeavors are published in the scientific literature and have or will influence the direction of research in government and academic laboratories.

Risk assessment activities of the Office of Health and Environmental Assessment are not limited to chemical substances, per se, but include organisms and their products as well. Within the past year, EPA has increased its activities in biotechnology. The Office of Health and Environmental Assessment working closely with the Office of Exploratory Research and the EPA Office of Pesticides and Toxic Substances has played a significant role in coordinating EPA research activities in this area. With assistance from the EPA Office of Pesticides and Toxic Substances, the Office of Health and Environmental Assessment successfully conducted an in-house workshop last December.

Activities are now underway to develop risk assessment approaches and guidelines for biotechnology. There are five geneticists and several micro-biologists and engineers with training in industrial fermentation on the staff of the Office of Research and Development and plans are being made to hire additional people in these fields. The Office of Health and Environmental Assessment is working to help the agency build a technical base for making regulatory decisions about biotechnology applications.

In conclusion, the Office of Health and Environmental Assessment has many functions. These functions include taking the lead responsibility for developing risk assessment guidelines, ensuring that agency health risks are conducted in a consistent and technically sound manner, performing risk assessments and providing technical assistance at the request of the program offices, developing new risk assessment methodologies and suggesting new research efforts that will better support future risk assessment procedures, and interacting with all levels of the environmental health science community. The functions demand that the technical staff in the office not only keep abreast of current scientific techniques but identify and promote the development of new techniques to support health risk assessment. □

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

AIR

Asbestos Emissions Standards

Final rules for amending portions of the national asbestos emissions standards have been announced. The rules reinstate some work practice and equipment safety provisions that were invalidated by a 1978 U.S. Supreme Court decision.

The new provisions 1) reinstate work-practice alternatives to the standards, providing additional means of compliance and greater flexibility to the owners and operators; 2) reinstate the work-practice standards in prohibiting the surfacing of roadways with asbestos tailings or asbestos-containing waste materials; 3) reinstate the prohibition of installation of certain commercial asbestos; 4) reinstate a partial exemption for demolition operations for structurally unsound buildings; and 5) reinstate the requirements that asbestos removed during demolition or renovation be kept wet until it is collected for disposal, and that asbestos not be dropped or thrown to the ground or a lower floor.

Asbestos removed more than 50 feet above ground level must be transported to the ground in dust-tight chutes or containers unless removed in units or sections. Requirements for warning signs and fencing around asbestos waste disposal sites are also reinstated. The 1977 amendments to the Clean Air Act gave EPA the authority to establish work practice rules in setting national emission standards for hazardous air pollutants, as called for by the Act.

Methanol Standards Considered

In response to the growing interest of auto manufacturers and others in using methanol as an alternative fuel for vehicles, EPA is inviting public comment on an advance notice of proposed rulemaking that would eventually establish methanol-fueled vehicle emission standards, certification test procedures, and a fuel equivalency factor for calculating fuel economy.

The Clean Air Act authorizes EPA to adopt requirements for all vehicles regardless of the fuel type. Methanol-fueled vehicles could become the third major type of certified vehicles subject to the same pre-production and in-use requirements as gasoline and diesel vehicles are now.

Engines designed to operate on methanol are more fuel-efficient than similar gasoline engines. Also, engines using methanol have relatively low emissions of both nitrogen oxides and particulates.

Methanol vehicles are expected to be similar in type, size, and functional ability to gasoline and diesel-fueled autos. Therefore, the certification and emission test protocols could be applied to methanol cars without undertaking any major change.

Methanol vehicles are being built in limited numbers by major automobile companies and other groups, agency officials said. In addition, test fleets are in operation in California and several other parts of the world.

Agency officials said these programs are an indication of the possibility that methanol-fueled vehicles could enter the marketplace in the near future. However, before they can be mass produced, the methanol-fueled vehicles would have to comply with emission standards, test procedures and fuel economy requirements.

Sanctions in Nashville

EPA has banned new or modified construction of major pollution sources in the Nashville, Tenn., area as a result of the city's failure to comply with the automotive emissions' inspection and maintenance requirements of the Clean Air Act.

Under the Act, areas of the country which could not meet federal ozone and/or carbon monoxide standards by 1982 were required to implement the vehicle tailpipe emission inspections. Nashville is currently in violation of the national ambient air quality standard for carbon monoxide.

In its 1979 state implementation plan (SIP), Nashville originally committed to the federal government to have an inspection and maintenance (I/M) program operating by Dec. 31, 1981. However, Nashville has not moved forward to establish the program, and just recently failed to reach agreement on a proposed contract to set up the inspection program.

Nashville is one of only three remaining areas in the country which is not meeting its I/M commitment. Michigan and Illinois have not made adequate progress in setting up auto emission inspections. Twenty-one states now have inspection programs in operation, with six expected to start tailpipe testing this summer, the agency said.

For any area not meeting its commitments under its implementation plan, the Clean Air Act imposes a ban on construction of stationary pollution sources for the pollutant involved, which in this case is carbon monoxide. The ban, which becomes effective immediately, means no permits will be allowed for construction of major new or modified sources in the Nashville/ Davidson County area that could contribute to carbon monoxide pollution. Major new and modified stationary sources of carbon monoxide could include municipal incinerators, foundries, certain major boilers and other industrial processes. A major source is one which emits 100 tons or more of the specific pollutant per year. The construction ban will be lifted when Nashville implements the auto emissions inspection program.

Nashville will also face a cutoff of federal highway funds for failing to submit an acceptable revised plan in 1982. The process to institute that cutoff is underway.

Unleaded Fuel Violation

Between Dec. 17, 1982 and April 1, 1983, Capital City Oil Co., a subsidiary of Mid States Petroleum Co., delivered leaded gasoline into unleaded storage tanks at retail stations owned or operated by Mid States, an EPA investigation disclosed. The stations displayed the Mid States or Union 76 trade names.

Now, under the terms of a unique and innovative settlement with Mid States, all concerned purchasers may return their vehicles to test for defects, and up to 3,000 new catalytic converters will be replaced free of charge where damages are confirmed.

Mid States also has agreed to pay $100,000 in civil penalties, adopt stringent quality controls for the future, and endow the University of Michigan and Detroit College of Law with donations promoting research and enforcement of the Clean Air Act.

Mid States Petroleum Co. will advertise and test unleaded cars and trucks at nine retail stations where the violations occurred. All qualified applicants will be given the opportunity for free catalyst replacements on a first-come first-serve basis at repair facilities in their area. Mid States has agreed to spend up to $350,000 in replacing catalytic converters where evidence of lead is detected within the exhaust system of unleaded vehicles which were contaminated between Dec.16, 1982 and April 1, 1983.

Use of leaded gasoline in cars designed for unleaded fuel can destroy a car's catalytic converter and result in a 200 to 800 percent increase in tailpipe emissions of hydrocarbons and carbon monoxide.

Under the Clean Air Act's unleaded fuels regulations, EPA can assess civil penalties up to $10,000 per violation against gasoline retailers, distributors, and refiners who sell leaded fuel represented as unleaded fuel.

SIP Revisions Approved

EPA has given final approval to six states and proposed approval to six states for revisions to Clean Air Act State Implementation Plans that will allow total actual increases of sulfur dioxide (SO_2) emissions. The increases represent approximately one-tenth of one percent of the total annual Eastern U.S. SO_2 emissions.

The agency is also issuing final disapproval for some of Kentucky's request for increases because air quality modeling indicates that the proposed increases would violate the Clean Air Act standards.

The Clean Air Act requires that the EPA Administrator approve any request for a revision of a State Implementation Plan if the emission increases meet a number of criteria, including attainment and maintenance of the national ambient air quality standards.

Final approval has been given for SO_2 increases for the States of Massachusetts, Mississippi, Kentucky, Virginia, Indiana, and New Hampshire. Proposed approvals are given for increases in New Jersey, Illinois, New Hampshire, Rhode Island, Ohio, and New York. In total, the revisions to the State Implementation Plans represent actual increases in SO_2 emissions of 16,000 tons per year while allowable emissions will increase by approximately 123,000 tons per year.

Allowable increases, as opposed to actual increases, reflect changes in the State Implementation Plan emission limits for specific sources to match the reality of what the source is currently emitting (actual emissions). Many of the allowable emissions limits were originally established at levels that are now determined to have been more stringent than necessary to meet the ambient air quality standards. None of the actual or allowable increases approved by EPA will result in violations of either the primary (health-related) or secondary (welfare-related) standards.

ENFORCEMENT

EPA Wins Dow Access

A consent decree signed by EPA and Dow Chemical Company settles a lawsuit involving EPA's authority to obtain internal information from Dow under the Clean Water Act. The settlement resolves a three-year dispute over EPA's efforts to obtain information on processes and waste streams inside the Dow complex.

The decree requires Dow to provide any internal information on production processes, other operations, or waste streams that EPA seeks for purposes of drafting water discharge permits; and to grant EPA access to its Midland facility to conduct sampling and analytical studies on any waste discharged from any process or other operations. In addition, Dow must perform studies requested by EPA to support the drafting of the wastewater discharge permit and ongoing EPA investigations.

This settlement guarantees the EPA broad access to any information that Dow develops concerning the presence, sources, and control of dioxins and furans at the Dow Midland facility, including access to review raw data from studies that are not complete.

In combination with the $48,450 settlement of a Toxic Substances Control Act (TSCA) penalty action on March 9, 1984, this settlement resolves EPA's outstanding enforcement suits against Dow's Midland, Mich., facility. The TSCA case, filed May 23, 1983, addresses the disposal of tetrachloro dibenzo-p-dioxin (TCDD) contaminated waste through the wastewater treatment plant and in the incinerator at Dow's Midland facility in 1980 and 1981 without giving EPA the 60-day notice required to review and possibly disapprove the proposed disposal method.

$4 Million Settlement

EPA has agreed to a settlement of contempt actions against Jones & Laughlin Steel, Inc. and its parent company, the LTV Corporation, for Clean Air Act violations at five steelmaking plants in Pennsylvania, Ohio, and Indiana. The Pennsylvania Department of Environmental Resources and the County of Allegheny are also parties to the agreement.

The settlement agreements establish new schedules for the installation of pollution controls and demonstration of compliance with Clean Air Act standards. They also require Jones & Laughlin and LTV to pay $4 million in penalties for violating past decree requirements, and undertake projects that will yield environmental benefits beyond what is currently required by federal and state law.

One of the most significant projects obligates Jones & Laughlin to share with the American steel industry, free of charge, the company's technology for the control of particulate emissions from blast furnaces.

The agreements are in settlement of three separate contempt actions initiated by EPA against Jones & Laughlin and LTV in January 1983 for violations of earlier air pollution abatement agreements. The violations involved failure to install pollution controls and to demonstrate compliance with particulate matter and sulfur oxide emission limitations at the company's plants in Pennsylvania, Ohio, and Indiana.

According to the terms of the agreement, the $4 million penalty will be split among the U.S. Treasury ($3 million) the Commonwealth of Pennsylvania ($500,000), and Allegheny County, Pennsylvania ($500,000).

Civil Penalty Policy

A new general civil penalty policy should improve EPA's ability to take a more consistent approach in pursuing civil penalties for violations of the nation's various pollution laws. The new policy calls for EPA to seek penalties that are at least as large as the profit a company may have realized by violating the law. And the amount of the penalty should take into account the environmental risk posed by the violation, the violator's efforts to correct it, the degree to which the violator tried to avoid compliance, the violator's history of noncompliance and the company's ability to pay a fine.

The new agency-wide policy consists of two documents, both of which provide guidance to EPA's program offices on how to develop their own specific policies. The first, "Policy on Civil Penalties," gives them an overall EPA enforcement policy, and the second document provides a set of guidelines for developing their own policy, called "A Framework for Statute-Specific Approaches to Penalty Assessments."

EPA's new penalty guidelines will become effective once the program offices finish developing statute-specific guidelines based on the general policy.

HAZARDOUS WASTE

Remedial Cleanup Manual

Options are newly available to states for expediting remedial cleanups under Superfund at uncontrolled hazardous waste sites. Described in an EPA manual, "State Participation in the Superfund Remedial Program," the options include:

- Multi-site EPA/State cooperative agreements to fund remedial planning activities at more than one site within a state;
- Management assistance cooperative agreements to cover costs states may incur during EPA-managed remedial activities;
- Extension, from six months to one year, of the maximum period during which EPA will share with a state the operation and maintenance costs at a remedial site.

Copies of the manual can be purchased from the U.S. Government Printing Office or the National Technical Information Service.

Uniform Manifest Rule

A manifest form requiring all transporters to provide uniform information on all shipments of hazardous wastes in the United States —whether by highway, rail, air, or water—is being promulgated as a new rule by EPA and the U.S. Department of Transportation.

The new regulation will require consistent information on the wastes being shipped, and will improve the tracking of shipments from the originators of wastes to a designated waste-handling facility. EPA and DOT worked with state, industry, and environmental representatives to develop the new form.

EPA regulations under the Resource Conservation and Recovery Act require generators to prepare a manifest to accompany all regulated shipments from the producer to the final treatment, storage, or disposal facility.

When the shipment is delivered, a signed copy of the completed form is returned to the originator. If a waste generator does not receive a completed manifest from the designated hazardous waste facility within 45 days, the generator must report the missing shipment or manifest.

PESTICIDES

Dicofol Review

EPA is initiating a special review of the pesticide dicofol after determining that its continued use may cause unreasonable risks to wildlife populations, particularly aquatic birds.

The review was triggered by data that show dicofol is contaminated by DDT and chemically-related compounds such as DDD, DDE and Cl-DDT. DDT, a once widely used insecticide, was banned in 1972 by EPA after it was shown to cause severe reductions in the reproductive levels of various fish and fish eating birds. Dicofol is used on agricultural crops and ornamental shrubs.

The nine to 15 percent DDT levels found in technical dicofol products are estimated by EPA to result in accumulated levels of about nine parts per million DDT in the bodies of fish. This level is greater than that known to affect reproduction by causing eggshell thinning in certain species of fish-eating aquatic birds. DDT is also known to be persistent, highly toxic to aquatic organisms, and to bioaccumulate through food chains.

EPA's review will weigh the benefits of dicofol to industry, growers, and society against the risk of continued use as required by the statute. At the conclusion of the review, the agency will decide either (1) to allow use to continue with certain restrictions and possibly ban some uses, or (2) to ban all uses.

New Pesticides Committee

EPA Administrator William D. Ruckelshaus has established a special pesticide advisory committee to assist the agency in addressing legislative and administrative issues critical to regulating pesticides.

Called the Administrator's Pesticide Advisory Committee (APAC), the proposed group will be made up of 16 members appointed to serve from one to three years. One of the first tasks of the committee will be to examine recommendations to amend the Federal Insecticide, Fungicide and Rodenticide Act.

Dr. John A. Moore, Assistant Administrator of Pesticides and Toxic Substances, has been designated to oversee the committee which is expected to complete its work within three years. All meetings will be public.

TOXICS

Asbestos Penalties

The Diocese of Pittsburgh and Southwestern City Schools, Grove City, Ohio have been assessed penalties of $23,200 and $36,000 respectively for violations of EPA's school asbestos rule.

EPA's first civil complaint under the rule, announced March 12, was against three schools in Goffstown, New Hampshire, and totalled $24,000; the second complaint, totalling $12,000, was issued March 15 against two schools in the Philadelphia system. EPA has also filed complaints against school systems in Cheyenne, Wyo. and Lebanon, Ohio.

Under EPA's school asbestos rules, issued May 27, 1982, all public and private elementary and secondary school administrators were required, by June 28, 1983, to have inspected their buildings, sampled and analyzed any friable materials for asbestos, notified employees and parents of any asbestos detected, and maintained records certifying compliance with the regulation.

Scientific evidence points to asbestos as a cause of lung cancer and of mesothelioma, a cancer of the membranes that line the chest and abdomen.

The administrative fines against these school systems may be reduced or remitted if the schools promptly take action to comply with the rule.

The Pittsburgh and Grove City schools have 20 days after receipt of the penalty notice to request a public hearing.

WATER

Coordinating Permits, Lease Sales

A Memorandum of Understanding between EPA and the Department of the Interior outlines coordination of environmental permits with oil and gas lease activities on the Outer Continental Shelf.

The agreement provides for the two agencies to coordinate studies and related regulatory responsibilities to ensure that EPA can issue the permits at the time Interior publishes a final notice that it is offering such leases.

The memorandum provides for early participation by EPA in Interior's environmental studies program and environmental impact statements, as well as giving EPA a mechanism for using information from Interior in issuing the National Pollutant Discharge Elimination System (NPDES) permits.

It also assures that whenever possible, these permits will be issued at the time Interior issues its final notice of lease sales, which will help prevent delays on offshore drilling operations by providing industry with early notice of permit conditions.

NPDES permits are required under Section 402 (a) of the Clean Water Act to regulate the discharge of pollutants from point sources such as oil and gas wells drilled offshore. Before issuing such permits, EPA in consultation with Interior seeks to identify any potentially productive or unique biological areas in the ocean that may be sensitive to discharges of pollutants from such drilling operations. An NPDES permit in these areas may contain effluent limitations to prevent the degradation of such waters.

The memorandum spells out terms under which EPA may issue general NPDES permits which may apply to entire tracts or planning areas in offshore lease offerings as well as individual permits. The timing of public hearings for draft permits will be coordinated with hearings for draft environmental impact statements, to assure full public participation in the process.

In addition, the memorandum described procedures under which EPA will share information with Interior on criteria involving the environmental vulnerability of lease areas, which may be used to suggest appropriate permit conditions. New source performance standards by EPA for such drilling will be coordinated with existing Interior procedures for environmental impact statements.

Office of Ground Water Protection

An Office of Ground Water Protection has been created to administer EPA's overall strategy in this area.

Marian Mlay was named as the Director of the new office. She has been Deputy Director of the Office of Drinking Water since 1979.

The Office of Ground Water Protection, which is part of EPA's Office of Water, will coordinate all EPA ground-water activities, develop policies and guidelines, and provide guidance to regional ground-water programs. It also will provide staff support to a Ground-Water Oversight Committee chaired by Jack Ravan, EPA Assistant Administrator for Water, and will manage a Ground-Water Steering Committee which will review policy and make recommendations on budget requests for this program.

EPA Administrator William Ruckelshaus said, "We have taken this action to deal with what EPA views as one of the major environmental problems confronting the nation in the 1980s—the contamination of our ground water. We are fortunate to have a manager of Marian Mlay's experience and knowledge to head this new organization, which will enhance EPA's institutional capability to protect this critical resource."

The new office is the focal point of efforts that are carried out by a number of EPA programs. Ruckelshaus said that an office to coordinate policy development activities was of paramount importance because regulations and programs affecting ground water come under the various laws EPA administers. They include the Resource Conservation and Recovery Act, Superfund, the Safe Drinking Water Act, the Clean Water Act, the Federal Insecticide, Fungicide and Rodenticide Act, and the Toxic Substances Control Act. □

Ruckelshaus Reviews Year at EPA

In a recent speech to the National Wildlife Federation EPA Administrator William Ruckelshaus reported on progress made in the first year of his second term as Administrator. Here are excerpts from his remarks:

A stream in the mountains of North Carolina.

"EPA has survived a difficult period of uncertainty and I think it's fair to say is now on the right track again. At the risk of sounding self serving, I believe that during the last ten months the agency has regained its morale — and we are doing what the law says we should be doing.

"This recovery of a sense of direction at EPA may have been inevitable, considering that the American people have expressed their commitment to the protection of public health and the environment in a broad array of legislation and citizen action over the past two decades. They value their environment deeply. That's why public support for the values EPA was created to protect has been so strong and persistent.

"Shortly after returning to EPA, I was given a report card by the Izaac Walton League. It was really more like a list of required courses with some pointed suggestions for fast action. The League was deeply concerned about the size and general thrust of EPA's budget, water quality issues, control of toxics, the clean-up of hazardous waste and our acid rain policy.

"Those were the very issues we at EPA were concerned about and I told the League that they would receive our immediate attention. They have. We have followed through and we have done well, almost certainly better than realists thought was possible in so brief a time.

"First, the budget. With the President's support I asked the Congress to provide additional funding for Fiscal Year 1984, and as a result, our operating budget has risen 27 percent overall since last May—47 percent if you include the Superfund. Growth of the Superfund between May 1983 and Fiscal Year 1985 will exceed 100 percent—up from $310 million to $640 million. In an era of huge deficits and great pressure on domestic spending this isn't bad in 10 months.

"Many have called for larger increases. But expanding a government agency rapidly is not easy and it can't be done in an instant. Pouring in too much money may not speed things up and it can be terribly wasteful. Instead, we have planned a deliberate, rational expansion in high-priority areas where the need for action is greatest.

"To make sure our new funds were invested wisely I recruited the best people I could find to manage EPA programs. Literally thousands of people volunteered last spring, including many from my first tour of duty, who had proven themselves under fire and who were willing to sacrifice their personal interests to help their country.

"Based on my recommendations, the President appointed 13 new top staff people with a total of 180 years of experience in governmental management, 32 of them at EPA. They were confirmed by the Senate without a single dissenting vote and are now serving with distinction.

"In FY 1985 we are requesting 750 additional work years above the 1984 level, 350 of which will be allocated to an intensified Superfund effort. During the first five months of FY 1984 we have hired 900 people, probably the fastest intake of staff in the agency's history, and I expect the pace will continue at a rate of at least 100 people per month throughout Fiscal 1984.

"Second, water quality. We reversed a previous EPA decision to downgrade water quality regulations. We have issued new rules that will make it easier for the states and the federal government, working together, to fulfill the intent of the Clean Water Act. We have set an effective process for altering standards where necessary, and tough anti-degradation requirements have been retained. We have task forces hard at work examining a number of urgent water related issues, such as nonpoint source pollution, waste treatment plant construction grants, ground-water management, pollution monitoring and clean-up of toxic waste dumps.

"Third, control of toxics. We have taken action to phase out EDB, develop a strategy for control of dioxin, regulate benzene, address the threat of PCBs, and initiate rulemaking on asbestos in schools, to cite only a few.

"EDB perfectly illustrates our more aggressive attitude these days. Nobody had done much about EDB for ten years, despite mounting evidence of hazard, until the new EPA took action to get this unacceptably risky compound out of the food chain.

"Fourth, hazardous waste. We will continue to stabilize imminent threats at uncontrolled hazardous waste sites through Superfund removal actions. In Fiscal Years 1984 and 85 we shall complete 300 emergency clean-ups. We have placed 546 of the most dangerous locations on our National Priorities List for early action because they pose the greatest risk of air, ground-water and surface water contamination.

"Clean-up is moving much faster now that we've dropped our requirement that the states pay 10 percent of the upfront costs of planning. We've delegated more authority to the EPA regions and adopted a philosophy of clean-up first — we can decide later who pays for it.

"We intend to use the Superfund remedial program to complete long-term, complex site cleanups. We have identified more than 17,000 hazardous waste sites in this country already and we estimate the total may go as high as 22,000. We are working virtually around the clock with the states to complete our site survey, rank the sites by degree of hazard and study long-term effects on public health.

"We will move vigorously to reduce the number of violations by major waste handlers.

"Fifth, acid rain. This has been my biggest disappointment. I've been trying to forge a consensus on this complex problem but none has emerged as yet from the whirlwind of conflicting opinion and diverse interests. I'm determined to continue to work to find a formula that will permit us to address this problem effectively.

"We have boosted our acid rain research budget from $15.4 million to $34.4 million in one year. The federal interagency acid rain effort will double to $55.5 million for research to support a national survey of some 2,000-3,000 lakes, plus periodic monitoring of several hundred lakes to establish baselines, determine actual damage and lay a foundation for appropriate action. And we are planning additional studies to determine whether acid rain has caused damage or changes in rate of growth and species composition in forests.

"We are working with our state agency counterparts to be ready to put a control program in place when Congress and the Administration can agree on the need and structure for it.

"No one can deny we have a problem. We're doing the necessary fact-finding and research to sharpen its outlines and ensure that if controls are imposed they can be as effective as possible. I can assure you that the door has not been closed on a control program.

"Despite the public demand for action it is more difficult to pass environmental legislation today than a decade ago. For one thing, the opposing sides seem to be farther apart. And the positions of the major players are not likely to soften during this election year. So it won't be easy to make major breakthroughs on our legislative agenda in 1984.

"In any event, the current concern about acid rain should not obscure the very real progress in cleaning the air that is being made. At the end of a recent five-year period pollutants in all six categories controlled by the Clean Air Act were trending down. To cite just one dramatic example, if the clean air legislation had never become law, sulfur dioxide emissions would have reached 40 million tons nationwide by 1980 instead of 27 million.

* * * * *

"Ours is probably the only age that has ever cared about the environment as an entity or ever had even modest resources to do something about it. In a little over two decades we have evolved from blithe indifference to irrevocable commitment, and I have no doubt that by the turn of the century this country will be safer and less defiled than it is now — even if we do no more than enforce existing laws.

"My optimism springs from a realistic assessment of where we were in comparison with where we are.

"Elsewhere in the world things are not so good. Indeed, the real challenge during the 80s and 90s may be to export environmental consciousness. You launched your magazine *International Wildlife* in 1971 in recognition that the earth constitutes but one ecosystem. Now that perspective is more vital than ever.

"We are on the move, and I believe with ever more resolute conviction that nothing, save deliberate self-destruction, can stop mankind from creating a higher form of planetary civilization." □

(Copies of the full text of this speech by Administrator Ruckelshaus to the National Wildlife Federation in Atlanta, GA. on March 17, 1984, can be obtained by writing to the EPA Journal.)

Appointments at EPA

Dr. Robert L. Dixon

Robert L. Booth

George Marienthal

Eight persons have been named to EPA posts by Administrator William Ruckelshaus. The appointments include Director of the Office of Health Research, Director of the Environmental Monitoring and Support Laboratory in Cincinnati, Director of Program Management and Operations in the Office of Water, Director of the Office of Policy Analysis, and Director of Integrated Environmental Management. Other positions are Chief of EPA's Regulatory Reform Staff, Associate Enforcement Counsel for Air, and Associate General Counsel for Water.

Filling the position of Director of the Office of Health Research is **Dr. Robert L. Dixon**. For the past 12 years, he has been with the National Institute of Environmental Health Sciences, first as chief of the Laboratory of Environmental Toxicology and then as chief of the Laboratory of Reproductive and Developmental Toxicology.

Along with his duties as laboratory chief, Dr. Dixon was assistant to the director of the Institute's international program from 1978 to 1981. From 1978 to 1979, he served on detail to the Office of Science and Technology at the White House as a senior policy analyst.

At the National Cancer Institute from 1969 to 1972, Dr. Dixon was chief of the Laboratory of Toxicology in the chemotherapy program. From 1965 to 1969, he was assistant/associate professor in the Department of Pharmacology, School of Medicine, University of Washington. Previously he was a senior investigator at the Laboratory of Chemical Pharmacology at the National Cancer Institute.

Dr. Dixon received a B.S. degree from Idaho State University in 1958, an M.S. in pharmacology from the University of Iowa in 1961, and a Ph.D. in pharmacology/toxicology from the University of Iowa in 1963.

Among his honors are the Society of Toxicology Achievement Award in 1962 and the National Institute of Health Director's Award in 1977. He has been a member of 18 scientific societies, published more than 60 scientific papers, participated in more than 25 advisory committees and study groups and was President of the Society of Toxicology from 1981 to 1982. A native of California, he is married, with three children.

Filling the position of Director of EPA's Environmental Monitoring and Support Laboratory in Cincinnati is **Robert L. Booth**, who has been acting director of the laboratory since 1980. In other positions at the laboratory, Booth was Deputy Director from 1976 to 1980 and technical coordinator from 1974 to 1976. In earlier work at federal water quality laboratory facilities in Cincinnati, he was first a chemist, later a research chemist and then a supervisory research chemist, from 1966 to 1974.

From 1955 to 1966, Booth was associated with the U.S. Public Health Service's Robert A. Taft Sanitary Engineering Center in Cincinnati, doing water quality research, undergoing graduate training from 1959 to 1962, and helping set up and supervise the International Joint Commission's field laboratory. From 1954 to 1955, Booth was technical director for the Western Paper Co. in Terre Haute, Ind.

He received an A.B. degree from Indiana State University in 1954, an M.S. from the University of Illinois in 1961, and did doctorate work at the University of Illinois. His honors include listing in *Who's Who in American Colleges* and cash awards as a federal employee.

Booth has published about 25 papers related to environmental measurements and quality assurance, served a three-year term on the board of the American Society of Testing and Materials, and represented EPA on the Joint Editorial Board of *Standard Methods*, the "bible" of the water and waste management field.

Born in Terre Haute, Ind., Booth is married and has one child.

Named to the post of Director of Program Management and Operations in the Office of Water is **George Marienthal**, a former EPA official. His most recent position, from 1981 until he rejoined EPA, was Vice President of Survival Technology, Inc., in Bethesda, Md., where he was responsible for the overall management of the firm's pharmaceutical business.

From 1975 to 1981, Marienthal was at the Department of Defense, where he was Deputy Assistant Secretary for Energy, Environment, and Safety, managing total Defense Department programs in these areas.

Marienthal was previously with the EPA from 1971 to 1975, serving as director of the Office of Regional Liaison and Director of the Office of Federal Activities.

From 1967 to 1971, he was Senior Research Associate for Logistics Management Institute in Washington, D.C., working as a management consultant for the Office of the Secretary of Defense and the National Aeronautics and Space Administration.From 1966 to 1967, Marienthal was a development engineer for the Air Force Contract Management Division in Los Angeles and from 1963 to 1966, he was chief of the Policies and Procedures Branch and Production and Procurement Officer for the Air Force Plant Representative, Lockheed Missiles and Space Company, Sunnyvale, Calif.

Marienthal received the EPA Bronze Medal in 1974, the Defense Civilian Distinguished Service Award in 1981, the National Defense Medal, outstanding performance ratings from 1978 to 1981 at the Defense Department, a Senior Executive Service Bonus Award in 1980, and is listed in *Who's Who in America*.

He graduated with a B.S. from the U.S. Naval Academy in 1962, an M.S. from Stanford University in 1963 and an M.B.A. from American University in 1974.

Marienthal's other activities include

Richard D. Morgenstern

Michael Levin

Michael S. Alushin

Colburn Cherney

long distance running, membership in the Institute of Industrial Engineers, ADPA Chemical Systems Steering Committee, and Association of Chemical Officers. He is married and has three grown children.

Named to the position of Director of the Office of Policy Analysis is **Richard D. Morgenstern**. From mid-1982, Morgenstern has been Director of the Office on a special assignment from the Urban Institute under the Intergovernmental Personnel Act.

Morgenstern was Director of the Urban Institute's Energy Program from 1980 to 1982. He was Senior Legislative Assistant to U.S. Senator J. Bennett Johnston from 1979 to 1980, and Deputy Assistant Director for Energy, Natural Resources and the Environment at the Congressional Budget Office from 1976 to 1979.

From 1971 to 1976, Morgenstern was a tenured Associate Professor of Economics at Queens College of the City University of New York. Prior to that he taught for a year at American University in Washington, D.C.

He received an A.B. degree from Oberlin College in 1966 and a Ph.D. from the University of Michigan in 1970. He graduated with high honors at Oberlin, received the Starr scholarship prize, and was awarded graduate fellowships under programs of the National Science Foundation and the National Defense Education Act.

Born in Brooklyn, he is married to Dr. Devra Davis. They have two children.

Appointed to the position of Director of Integrated Environmental Management is **Dan Beardsley**, who has held several different posts at EPA since 1980. He was responsible for overall management of the Integrated Environmental Management Division, staff director of the Intra-Agency Toxics Integration Task Force, and responsible for management of the Interagency Risk Management Council, reporting to the Administrator of EPA.

Previously, Beardsley was Special Assistant to the Director of the federal agency ACTION from 1979 to 1980. He was a project director at the National League of Cities from 1978 to 1979. He served as a program manager at the National Assn. of State Drug Program Directors from 1977 to 1978, served as a deputy project director for A.J. Nellum & Associates in Atlanta from 1976 to 1977, and served as a project director from 1975 to 1976 for Atlanta Mayor Maynard Jackson.

In earlier positions, Beardsley was a planner for the City of Atlanta in 1975, an administrator and program director with the State of Georgia from 1972 to 1975 and a minister and university chaplain in Gainesville, Fla., from 1968 to 1971.

He received a B.A. from Kalamazoo College in Kalamazoo, Mich., in 1966 and an M.Div. from Yale University in 1972. Born in Detroit, he is married and has two children.

Named as Chief of EPA's Regulatory Reform Staff is **Michael Levin**, who for the past four years has been serving in this capacity under several interim assignments.

From 1977 to 1979, Levin served as Deputy Director of a Presidential task force on regulatory reform and as legislative aide on regulatory matters to several Congressmen and the Senate Judiciary Committee.

From 1972 to 1977, Levin was Counsel for Appellate Litigation, U.S.Department of Labor, responsible for litigation of all court cases under the Occupational Safety and Health Act (OSHA).

Levin graduated from the University of Pennsylvania with a B.A. in 1964, from Harvard Law School with a J.D. in 1969, and from Oxford with a B.Litt. in 1970. He received EPA's Gold Medal in 1982.

Born in Philadelphia, Levin is married and has two children.

Named as Associate Enforcement Counsel for Air was **Michael S. Alushin**. Since 1982 he has been acting in the position, which manages Clean Air Act enforcement litigation in the Office of Enforcement and Compliance Monitoring. During 1981 to 1982, he held various positions in the former Office of Enforcement Counsel, including acting Deputy Enforcement Counsel, Director of Special Programs staff, and attorney/advisor. In other service at EPA, Alushin was a Senior Environmental Fellow in the Office of Planning and Management from 1980 to 1981.

Alushin was Director of the Bureau of Regulatory Counsel in the Pennsylvania Department of Environmental Resources from 1978 to 1980 and was an assistant attorney general handling environmental enforcement cases in the Bureau from 1972 to 1980. His other work included serving as a law clerk in a New York law firm and a management intern with the Defense Contracts Administration Service in Cleveland.

Alushin received a B.A. degree magna cum laude from Oberlin College in 1969 and a J.D. degree from Harvard Law School in 1972. His honors include Phi Beta Kappa, an EPA Special Achievement Award and an EPA outstanding performance rating, both in 1982. He is married and was born in Cleveland.

Filling the position of Associate General Counsel for Water in the Office of General Counsel is **Colburn Cherney**. He has been acting in the position since last year. From 1981 to 1983 he was Assistant General Counsel in the Office of General Counsel and from 1974 to 1981 he was a general attorney in the Office.

Cherney received a B.A. degree from the University of Wisconsin in 1970 and a J.D. from the University of Wisconsin Law School in 1974 graduating with honors. He received an EPA Silver Medal in 1980 and EPA performance awards in 1980 and 1982. He was born in Green Bay, Wisc., and is married.

Environmental Almanac

Destiny on a Beach

On a moonlit night soon a female horseshoe crab will be pulling herself out of the ocean and onto a sandy beach to lay her eggs as members of her species have been doing for millions of years.

Many of the tiny eggs buried annually by this crab and thousands of her fellow creatures on the sands of Cape May, N.J., will provide vitally needed food for shore birds, including a remarkable long distance flyer, the Red Knot.

The Knot, a bird only a little larger than a robin, will be winging in from Argentina on its way to nesting grounds in Canada. These shore birds fly thousands of feet high and make few stops on their way north.

Their need for food is critical when they descend on such migration resting places as Cape May. Despite the fact that Knots and other shore birds have long been feeding on these eggs, the horsehoe crab continues to be one of the most successful survivors in the world.

Called living fossils, these so-called crabs are descendants of creatures who lived more than 200 million years ago. Unprepossessing animals, which are actually marine arthopods and not crabs at all, they acquired their common name because their shells resemble the shape of a horse shoe. They are well adapted to the soft mud or sand where they live in shallow seas.

An important key to their survival is that the females lay so many eggs that there have always been many left over to continue the species, no matter how ravenous the appetites of shore birds and other predators.

When the female crab arrives on shore she is accompanied by smaller male crabs who cluster around or cling to her and promptly fertilize her eggs.

The success of the egg laying can help determine not only the size of the future horseshoe crab population but also how many Red Knots will be hatched in Arctic Canada.

The emergence of the crabs from the sea to lay their eggs is determined by water temperature and the timing of high tides pulled by the moon's gravity.

These factors must mesh with the arrival of these shore birds from South America, often despite driving rain and violent wind storms.

Peter Dunne, Director of the famed Cape May Bird Observatory, reports that this institution is preparing a major long-term research project to study the links between shorebirds and horseshoe crabs at Cape May. Preliminary aerial surveys of shorebird concentrations have indicated that the population, which sometimes mounts to hundreds of thousands, can fluctuate widely, depending presumably, at least in part, on the timing and quantity of horseshoe crab eggs.

Last year when horseshoe crabs delayed laying their eggs at Cape May until the end of May and early June because of cool water temperatures, the population count for Red Knots alone dropped from more than 100,000 in 1981 to about 33,000, according to the Cape May Bird Observatory records.

After their feeding stop at Cape May, the Red Knots resume their long annual migration. In Northern Canada they fly over tundra country in the Arctic Circle. In breeding season they sing a melodious but plaintive song which sounds like "Poor Me," according to Peter Matthiessen, a noted writer about shore birds.

For many years ornithologists had searched unsuccessfully for the nests of the Red Knot. Finally a few nests were found by Admiral Robert E. Peary on Canada's Ellesmere Island while he was journeying homeward after discovering the North Pole in 1909.

But why do we really care about the horseshoe crab or the Red Knot? Aren't there many other more pressing matters in the world? An answer to questions like these was once given by J. Henri Fabre, the noted French entomologist and writer:

"Is it not childish to inquire so minutely into an insect's actions? Too many interests of a graver kind hold us in their grasp to leave leisure for these amusements. That is how the harsh experience of age impels us to speak; that is how I should conclude...if I did not perceive, amid the chaos of my observations, a few gleams of light touching the loftiest problems which we are privileged to discuss...What is life? Will it ever be possible for us to trace its sources? What is human intelligence? What is instinct?...These questions are and always will be the despair of every cultivated mind, even though the insanity of our efforts to solve them urges us to cast them into the limbo of the unknowable." —C. D. P.

Karen Ekstron, a geologist, using a portable electromagnetic induction device to test for toxics in the environment. Ms. Ekstron is with the Environmental Monitoring Systems Laboratory in Las Vegas.

Back Cover: Patricia Blau, a chemist at the Research Triangle Institute, wears a vest containing personal air quality monitoring equipment used in an EPA research project, as she works with scientific equipment in her laboratory at the Institute. *(See story on P. 7)*

United States
Environmental Protection
Agency
Washington DC 20460

Official Business
Penalty for Private Use
$300

Third-Class Bulk
Postage and Fees Paid
EPA
Permit No. G-35