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CLEAN AIR ACT: REVIEW AND OVERSIGHT

HEARING

BEFORE THE

SUBCOMMITTEE ON CLEAN AIR, WETLANDS, PRIVATE PROPERTY, AND NUCLEAR SAFETY

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS
UNITED STATES SENATE

ONE HUNDRED SIXTH CONGRESS

FIRST SESSION

OCTOBER 14, 1999

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CLEAN AIR ACT: REVIEW AND OVERSIGHT

THURSDAY, OCTOBER 14, 1999

U.S. SENATE,
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS,
SUBCOMMITTEE ON CLEAN AIR, WETLANDS, PRIVATE PROPERTY, AND NUCLEAR SAFETY,
Washington, DC.

The subcommittee met, pursuant to notice, at 9:03 a.m., in room 406, Senate Dirksen Building, Hon. James Inhofe (chairman of the subcommittee) presiding.

Present: Senators Inhofe, Crapo, Voinovich, Lieberman, and Baucus [ex officio].

OPENING STATEMENT OF HON. JAMES M. INHOFE, U.S. SENATOR FROM THE STATE OF OKLAHOMA

Senator INHOFE. The meeting will come to order.

Today marks the first Clean Air Act reauthorization hearing. It is part of what I hope will be a 4-year process that we will be able to get through to reauthorize. Last time, I understand it took about 10 years, but we shouldn't have any problem doing it in a shorter period of time. I don't anticipate a complete rewrite, as we went through in 1990, but instead more of a fine tuning of the process.

The Clean Air Act has had many successes, but it has had its share of failures, too. No law is perfect, and every law could benefit with some reforms and changes. Of course, the hard part is going to be agreeing on what those reforms will look like. As the Chairman of the Clean Air Subcommittee, I am not proposing a complete rewrite of the law; instead of using a club, we will use a surgical scalpel.

What I would like to do at this point is highlight a few of the Clean Air Act's notable successes and failures.

First, the air pollution is down. In almost every category, the amounts of pollutants have decreased substantially and, in general, people are breathing healthier air than they were 10 or 20 years ago. But I am not sure that they realize that.

Second, the 1990 amendments incorporating market-based approaches have worked. These approaches need to be expanded to other statutes and other sections of the Clean Air Act.

Third, the 1990 amendments provided a framework for State decisionmaking ability. We need to make sure that this trend continues.

In the area of failures:

First, risk tradeoffs. The act of chasing after pennies of benefits for dollars in costs through its failure to identify the most cost-effective risks we face as a Nation.

Second, sound science policy judgment calls have been confused with statements of fact regarding the science. As a result, the EPA has lost credibility. We need to find ways to involve outside panels of scientists, such as CASAC. During our ambient air efforts, we did not really utilize the Clean Air Science Advisory Committee as I think it was intended to be used, and I would like to see us expand the use of the talent that we have available to us.

Third, exposure. Proving a chemical is toxic alone is not enough to justify a massive regulatory program. We have to understand what the human and environmental exposure routes are before we regulate, not just proving it is toxic.

Fourth, we need to open up the decisionmaking process. Too many of the EPA's decisions have been negotiated behind closed doors and through settlements. The American public deserves to know more about this process. I think we know about the consent decrees and these are the things that we would like to address.

These broad issues will be discussed during the second panel. The third panel will cover specific issues such as the MACT process, the acid rain program, and the effect of the multiple regulations addressing the same pollutant.

These are just a few observations. I hope today's hearing will begin a public dialog on what the next version of the Clean Air Act will look like. I intend to followup this hearing with additional reauthorization hearings next year, with at least one hearing focusing on States and local governments.

Senator Baucus?

Senator BAUCUS. I'm not ready yet.

Senator INHOFE. All right. Senator Crapo?

OPENING STATEMENT OF HON. MICHAEL D. CRAPO, U.S. SENATOR FROM THE STATE OF IDAHO

Senator CRAPO. Thank you very much, Mr. Chairman. I appreciate your allowing me to sit with the committee today. These hearings hold very important consequences for my State, as they do all States, and we have had a number of important issues in Idaho that directly involve the Clean Air Act and the implementation of the Act. I would like to welcome Mr. Perciasepe here today. He has been very helpful in working with me and our State in trying to help us get through some of the problems that we have faced in the implementation of the Act.

I look forward to these hearings and hope to work very closely with you as we work to see if we can't get better risk assessment and cost-benefit analysis into the law in a way that will help to reach that balance between making sure that we protect the environment adequately yet make sure that the burden on industry and on the American public in other ways is not excessive. Thank you.

Senator INHOFE. Thank you, Senator.

Senator Voinovich?

OPENING STATEMENT OF HON. GEORGE V. VOINOVICH, U.S. SENATOR FROM THE STATE OF OHIO

Senator VOINOVICH. Thank you, Mr. Chairman. First of all, I would like to thank you for conducting this very important hearing today on the Clean Air Act reauthorization.

I would also like to extend a welcome to Bill Tyndall, vice president of environmental services at Cinergy Corporation in Cincinnati, Ohio. Cinergy is one of our most responsible citizens in the environmental area and I am pleased that Mr. Tyndall will join us today. In addition, I would like to welcome John Graham from the Harvard Center for Risk Analysis. John and I have worked together on efforts to pass regulatory reform legislation, and John was a guest speaker before the Natural Resources Committee when I was Chairman of the National Governors Association.

Mr. Chairman, I know that you want us to keep our remarks short, and I was going to go into Ohio's great environmental record before my remarks. But in brief, I just want to say, as a former commissioner, mayor, Governor, Ohio has been very responsible in the environmental area. I am proud of the fact that while I was Governor we made up our mind that we were going to get all of our urban areas into attainment on our ozone standard, and by the time I left office, all of them were in attainment except one, Cincinnati, and they are now waiting for the EPA to approve them.

I have been concerned a long time about the fact that the Environmental Protection Agency was not taking into consideration risks, costs, benefits, and sound science during their rulemaking process. And I was particularly concerned about their ozone and particulate standards and the NOx SIPP call.

I spent over one hundred hours, in fact, trying to convince the Environmental Protection Agency, the Clinton Administration, and Members of Congress and members of this committee that the cost of the new standards in this country far outweigh the benefits to public health and the environment. In fact, according to EPA's own estimates, the costs for implementing the NAAQS standard for ozone exceeded the benefits. The President's own Council of Economic Advisers predicted that the benefits would be small while the cost of reaching full attainment could total some $60 billion.

I would like to note that Senator Inhofe provided significant help to the States by amending TEA–21 to help provide more reasonable timelines to implement ozone and particulate matter requirements. We really appreciated that concern on your part, Senator.

Federal agencies should not be in a position to force governments, businesses, and consumers to throw billions of dollars at a problem without knowing if they are hitting the right target. So often we forget that some of these regulations force governments to spend money that is badly needed for other areas of responsibility. I will never forget when Administrator Browner, prior to the final NAAQS standard, told me that her hands were tied, that statutorily she could not use risk assessment and cost-benefit analysis in her consideration for final regulation. I think it is time that we gave her that authority.

I am going to introduce a bill soon that will require EPA to conduct an analysis of cost and benefits while providing the Agency with flexibility in making final regulatory decisions. In fact, the bill

I am about to introduce mirrors the risk assessment and cost-benefit analysis provisions that are in the Safe Drinking Water Act, which had strong bipartisan support and was signed into law by President Clinton in 1996. I merely state the obvious. If that provision was good enough for the Safe Drinking Water Act, it ought to be good enough for the air that we breathe.

I have no doubt that using risk assessment and cost-benefit analysis will help ensure that reasonable and cost-effective rules are being set. I also believe that these analyses will help ensure that the air regulations, ones that are based on sound science, will actually be implemented in a more timely manner because they won't be tied up in lawsuits. We could be so much further along if we had just used risk assessment and cost-benefit analysis.

This is really about letting the public know how regulations are made. We need to make the Federal Government more accountable to the people it serves. When EPA is setting clean air standards, they should answer several simple, but vital, questions. What science is needed to help make good decisions? What is the nature of the risk being considered? What are the benefits of the proposed regulation? How much will it cost? Are there better, less burdensome ways to achieve the same goals? Thank you, Mr. Chairman.

[The opening statement of Senator Voinovich follows:]

STATEMENT OF HON. GEORGE V. VOINOVICH, U.S. SENATOR FROM THE STATE OF OHIO

Mr. Chairman, I want to thank you for conducting this very important hearing today on the subject of Clean Air Act Reauthorization.

As a father and grandfather, I understand the importance of ensuring a clean environment for our future generations. Throughout my 33 years of public service, I have demonstrated a commitment to preserving our environment and the health and well-being of all Ohioans. I sponsored legislation to create the Ohio Environmental Protection Agency when I served in the State legislature, and I fought to end oil and gas drilling in the Lake Erie bed. As Governor, I increased funding for environmental protection by over 60 percent. While in the Ohio House of Representatives, I was responsible for creating the Environment and Natural Resources Committee and was honored to serve as vice chairman of that committee.

In addition, the State of Ohio realized significant improvements in air quality in recent years. When I first entered office as Governor in 1991, most of Ohio's urban areas were not attaining the 1-hour ozone standard. By the time I left office in 1998, all cities had attained the standard, except one. However, Cincinnati is now meeting the standard an is awaiting action by the EPA.

Overall, the ozone level in Ohio has gone down by 25 percent and in many urban areas, it has gone done by more than 50 percent in the past 20 years. Ohio is doing its part to provide cleaner air. Nevertheless, over the years, I have become more and more concerned that just in order to comply with Federal laws and regulations, our citizens, businesses and State and local governments must pay costs that can be inordinately burdensome or totally unnecessary.

In the 104th Congress, I worked closely with a coalition of State and local government officials and members of the House and Senate to pass effective safe drinking water reforms. The results of our efforts culminated in the Safe Drinking Water Act Amendments, legislation which was enacted with broad bipartisan support in 1996. In addition, the bill had the support of environmental organizations and I was pleased to attend the President's bill-signing ceremony when these reforms were signed into law. This cooperative effort is notable because it showed that a law could include common-sense reforms that make the government more accountable based on public awareness of risks, costs and benefits. I believe it set a key precedent for reform of environmental regulations.

I specifically mention the drinking water program because it includes risk assessment and cost benefit analysis provisions that I strongly believe should be part of the Clean Air Act. In fact, I am about to introduce a bill that would do just that. Under my bill, the EPA would be required to conduct an analysis of incremental

costs and benefits of alternative standards, while providing the agency with flexibility in making final regulatory decisions.

My bill is a common-sense approach that merely addresses the obvious: if it's good enough to protect the water that we drink, then it should be good enough to protect the air that we breath. It will also help us avoid some of the legal and legislative wrangling that has occurred with respect to how we achieve clean air.

When I was Governor of Ohio, I became more and more concerned that the EPA was not taking into consideration sound science, costs and benefits during the rulemaking process. I was particularly concerned about the standards for ozone and particulate matter and the NOx SIP call. In fact, I spent over 100 hours trying to convince the EPA, the Clinton Administration, Members of Congress and members of this committee that the costs to this country to implement the new National Ambient Air Quality Standards (NAAQS) far outweighed the benefits to public health and the environment.

In fact, according to EPA's own estimates, the costs for implementing the NAAQS standard for ozone exceeded the benefits. The President's own Council of Economic Advisors predicted that the benefits would be small, while the costs of reaching full attainment could total $60 billion.

Just this spring, a U.S. appeals court remanded EPA's ozone and $PM_{2.5}$ standards, ruling that EPA did not justify its decision with sound scientific evidence. Ohio was a party to this lawsuit, which began when I was Governor. The court didn't say that EPA couldn't regulate at these levels, but that EPA didn't give justification for doing so.

That has been my point all along. I have argued that the NAAQS standards and NOx SIP call were going to be costly and that we didn't even know if making those investments was going to make a difference.

Federal agencies should not be in the position to force businesses and consumers to throw billions of dollars at a problem without knowing if they're hitting the right target. Yet, the EPA is asking all of America to pay for these new regulations simply because the EPA said it is the right thing to do. However, they have failed to adequately determine the effects of changing the ozone and particulate matter standards.

In an effort to make my case with Administrator Browner regarding the new NAAQS standards, I told her the facts were inadequate to make the case for these standards. Instead of improving public health, they would divert resources from programs that make a real difference in protecting human health and the environment. However, she told me that her hands were tied, that statutorily she could not use risk assessment and cost-benefit analysis in her consideration of final regulations. At that point I realized it was essential to provide EPA the authority to take costs, benefits and risk into consideration during the rulemaking process. And it is important that the public know what information has been used in finalizing the rules that affect our air quality.

I have no doubt that using risk assessment and cost-benefit analysis will help ensure that reasonable and cost-effective rules are being set, and which have the science to back them up.

The challenge facing public officials today is determining how best to protect the health of our citizens and our environment with limited resources. We need to do a much better job ensuring that regulations' costs bear a reasonable relationship with their benefits, and we need to do a better job of setting priorities and spending our resources wisely.

We need to make the Federal Government more accountable to the people it serves. When EPA is setting Clean Air standards, they should answer several simple, but vital questions:

What science is needed to help us make good decisions?
What is the nature of the risk being considered?
What are the benefits of the proposed regulation?
How much will it cost?
And, are there better, less burdensome ways to achieve the same goals?

Thank you Mr. Chairman, I look forward to hearing today's testimony.

Senator INHOFE. Thank you, Senator Voinovich.

Senator Baucus?

OPENING STATEMENT OF HON. MAX BAUCUS, U.S. SENATOR FROM THE STATE OF MONTANA

Senator BAUCUS. Thank you. Mr. Chairman, I very much appreciate your holding these hearings. The Clean Air Act has served

this country very well, but it is always good to take stock and look to see where we are. This is a very important hearing. I understand you will be holding a series of them overseeing the Clean Air Act.

Mr. Chairman, as you know, it takes a long time to make a good product; it just doesn't happen overnight. But overall, I think we did a pretty good job with the amendments of 1990. We worked hard, very hard, this committee did with the full Senate and the House. It is not perfect, but it is good. We can't let perfection be the enemy of the good, and that certainly applies to the Clean Air Act. It is a good Act. It has worked. There are some problems with it, but basically it worked.

The air we all breathe today is considerably cleaner than it was prior to the Act. Total emissions of major pollutants have been cut by a third since 1970. At the same time, our economy has prospered. Gross Domestic Product has more than doubled. The population increased by nearly a third. We have proved that we can meet stringent air quality standards and have a vibrant, growing economy at the same time.

One of the issues our witnesses will discuss is the use of cost-benefit analysis. I am not adverse to applying cost-benefit or risk-benefit analysis when it makes sense. We applied it, as has been mentioned, to the Safe Drinking Water Act standards-setting process in 1996. In that case, drinking water systems are clearly defined and costs, risks, and benefits are easier to calculate. But developing clean air standards does not lend itself easily to cost-benefit analysis. Calculating exposure and risk are significantly more complicated. Furthermore, I challenge anyone to put a dollars and cents value on a child's reduced IQ due to exposure to lead.

The right way to go about setting clean air standards is to figure out what the scientists, what the doctors, what the experts say are the levels needed to protect public health. Then we can figure out how to cost-effectively implement them. That formula has been working well since 1970. I have not seen compelling evidence that we should break the success.

There are many issues that need to be addressed in the next authorization. For example, how well does the Act facilitate regional cooperation in dealing with pollutants. We should also examine EPA's and the States' flexibility to fashion the most cost-effective programs to meet air quality standards. We could probably also do a better job of monitoring and determining exposure than we have in the past. There are plenty of other challenges that also need attention, not the least of which is that almost half the population lives in an ozone nonattainment area, breathing unhealthy air. And despite new controls, more than 8 million tons—8 million—of toxic air pollutants are still being emitted each year.

I hope we will be able to pursue these and other issues in the coming hearings. I again thank you, Mr. Chairman, for holding this hearing. One other view about sound science. We all talk about sound science. Everybody wants sound science. Of course, we want sound science. But I must remind us that sound science is not the answer; it is only the beginning, because sound science will tell us what the level of certain contaminants might be, what the level of certain pollutants will be, but the final decision has to be made

right here as to whether that is the acceptable level or not. The policy decision is what to do after we find out what sound science determines.

So whenever we use the term "sound science," I hope everyone realizes and remembers that it is passing the buck because it is not going to solve the question. The question is going to have to still be solved by Congress as to what to do after we get the data from sound science, what is the right public policy after we get the sound science. I just again remind us all that we set the policy standards. The scientists give us the data but we, again, set the standards.

Senator INHOFE. Senator Baucus, I don't disagree with that. I think the statement that you make that the policy is made after we hear the sound science, I want to make sure that is plugged in someplace along the way.

Senator BAUCUS. Oh, sure it is. As I said, Mr. Chairman, I think we should first listen to the scientists, listen to the doctors, listen to the experts as to what the health consequences will be, what the standards should be to protect public health, and then we figure out what the best cost-benefit analysis way is to finding a way to achieve that standard. I ask the question again, what dollars and cents values and with a cost-benefit are you going to put on a child who has reduced IQ due to lead exposure?

Senator INHOFE. Senator Lieberman?

OPENING STATEMENT OF HON. JOSEPH I. LIEBERMAN, U.S. SENATOR FROM THE STATE OF CONNECTICUT

Senator LIEBERMAN. Thanks, Mr. Chairman. I appreciate very much that this morning we are meeting for the first of what I understand will be a series of hearings leading up to the reauthorization of the Clean Air Act.

Personally, passing the Clean Air Act Amendments of 1990 was one of the most significant legislative efforts I have been involved in since I came to the Senate in 1989. I strongly supported those amendments and am very proud of the way we worked across party lines on this committee and with the Bush Administration to make changes, that is the George Bush, Senior, Administration, to make changes in the Act that improved the quality of our Nation's air. I think that we can all look back at the Clean Air Act Amendments of 1990 as one of this decade's biggest environmental success stories, and I believe, along with the Clean Water Act, one of the best things Government has done in the last three or four decades.

Most places in America today have cleaner air than they did in 1990, including some of our cities, many of our cities. Concentrations of pollutants like lead, carbon monoxide, sulfur dioxide, and ozone have declined significantly. Clearly, there is much to be proud of and I applaud EPA for its work implementing the requirements of the Act. I would like to make particular mention of the Agency's effort to develop a regional smog strategy and to take Federal actions to enforce emissions controls for sources that contribute to regional pollution, which mean a lot to us in a State like Connecticut.

But certainly there remains much more to be done. The fact is that 117 million Americans live in areas today where it continues

to be unsafe to breathe the air because of ozone and smog pollution. Asthma rates among children are up by 75 percent since 1990, that's a fact, making them significantly more vulnerable to smog pollution. Transported pollution still causes tremendous problems, in some instances it has been measured at levels that exceed the public health standard by 80 percent.

There are several areas of the Clean Air Act that I think warrant consideration as part of the reauthorization dialog that we are beginning this morning. For example, a series of requirements in the 1970 and 1977 amendments required that utility plants meet new source performance standards for pollutants, like nitrogen oxides and sulfur dioxides. These standards were only imposed on new plants since it was thought that the older plants would be retired in the near future. Yet, of the 1,000 power plants operating in our country today, 500 were actually built before the regulations of the 1970's were enacted. So as we consider our responsibility in reauthorizing the Clean Air Act, it seems to me that it is essential that we close this loophole. Simply requiring the Nation's older power plants to meet the same standards that apply to new facilities would reduce utility emissions by 75 percent.

Since the 1990 amendments, evidence of the impacts of global climate change has continued to mount. Greenhouse gas concentrations have continued to increase despite our international commitment to stabilize them at 1990 levels. As power plants and other major sources make changes to reduce nitrogen oxide, sulfur dioxide, and mercury, reduction of carbon dioxide emissions must also be considered as part of the equation so that the utilities can respond in the most cost-effective fashion.

Regarding acid deposition, clearly identified now as an issue of national not only regional concern, which is was when we considered it in 1990. While we have made progress in reducing the emissions of sulfur dioxide, I look forward to hearing from today's witness from the Adirondack Council about where more may be required if we are to slow down the degradation of our Nation's environment and ecosystems.

Continued action to reduce the sulfur content of fuels and reduce mobile sources of air pollution is certainly one way to address that issue. While average emissions per vehicle have declined, vehicle miles travelled have continued to rise significantly. In addition, as we all know, the size of the average car has increased in recent years. We didn't envision growth in this way when we looked at mobile sources of pollution in 1990. And I continue to believe that we need to examine additional emission controls on vehicles because they can be, and are, technologically feasible and certainly can be cost-effective.

Finally, Mr. Chairman, I would like to offer, in some ways joining with my colleague from Montana, some words of caution on the issue of applying cost-benefit analysis to the Clean Air Act. All of us seek to apply the most cost-effective policies and technologies to address environmental problems. We would be irresponsible if we didn't do that. The challenge that we face, however, is full of uncertainty. Anticipating the innovations of tomorrow requires the kind of foresight that most of us don't have, particularly with the extraordinary pace of technological innovation and progress.

Because of that uncertainty, expectation from the cost of meeting clean air objectives has, in fact, been way off the mark as we look back. For example, in 1990, the utility industry predicted that acid rain controls would cost $1,500 per ton of clean up and the leading industry trade group estimated that the law would cost about $100 billion each year. In fact, acid rain is being cleaned up at prices 94 percent less than was anticipated for chlorofluorocarbons, CFCs. Cost of compliance fell by 30 percent despite an accelerated timetable that was imposed for phase-out of the chemical. Both technology development and market system innovations have, therefore, significantly reduced the costs of meeting these environmental challenges. It is another example of the extraordinary resourcefulness and resilience of the American people, and American industry particularly, when faced with a challenge.

While it is one thing to identify a clean air goal based on a public health objective and to say that the cost-effective implementation requires a long timeframe, it is quite another to say to the public that we can't let them know whether the air is clean enough to breathe because the standard doesn't meet a cost-benefit test.

So, Mr. Chairman, I thank the witnesses for coming here today. The challenge of reauthorizing the Clean Air Act takes us now along a path which will be long and it will have many turns, and the input from stakeholders, like those here today, will be an essential part of the journey we embark on. I thank you very much, Mr. Chairman, for beginning this effort today with this hearing.

Senator INHOFE. Thank you, Senator Lieberman.

Since we have three panels today and seven witnesses, we are going to adhere to the 5-minute rule on the opening statements with the exception of Mr. Perciasepe. Since he is the only witness from the Administration, we will give him 10 minutes. But we will try to restrict our questioning time to 5 minute rounds in order to accommodate our schedule in getting out.

We are all familiar with Bob Perciasepe, the assistant administrator, Office of Air and Radiation, in the U.S. Environmental Protection Agency.

Mr. Perciasepe?

STATEMENT OF ROBERT PERCIASEPE, ASSISTANT ADMINISTRATOR, OFFICE OF AIR AND RADIATION, U.S. ENVIRONMENTAL PROTECTION AGENCY

Mr. PERCIASEPE. Thank you, Mr. Chairman, Senators, it is a pleasure to be here today with you to talk about the Clean Air Act. I will try to do this within 10 minutes, but I appreciate the indulgence of the Chair.

I think it has already been said several times but it stands repeating. The 1990 amendments passed with overwhelming support in both the Senate and the House of Representatives and were, of course, signed by President Bush, as was mentioned. It was strong bipartisan legislation and it was designed to achieve results. Air pollution at that time was damaging aquatic life with acid rain, smog exceeded health standards in 98 cities, carbon monoxide was a problem in dozens of cities, and no progress was being made on hazardous air pollution, just to name a few issues that were facing the Congress in 1990.

But we have made tremendous progress. You see on my chart here—I've given each one of you a copy too—that we have made a lot of progress. Some of these have been mentioned, but let me put a little point on some of these that are also in my written testimony.

Reducing acid rain. We have already reduced 5 million tons, and we are on track to the 10 million ton goal that Congress had set. Acidity in precipitation has been cut in some areas by 25 percent.

Decreasing smog and soot. Back in 1990 we had 98 areas that were nonattainment for ozone, and 62 of those areas now have air quality meeting that standard. We had 41 areas in nonattainment for carbon monoxide, 35 of those areas have come into attainment. And for the course particle soot standard we had 85 areas in nonattainment, 71 of those areas have achieved air quality meeting the standards.

On industrial air toxic emissions. Forty-three standards have been put out and 70 industrial categories are included. This will result in 1.5 million tons of toxic reductions and also VOC and particulate reductions.

Often overlooked in our discussion of the Clean Air Act is that there was a strong commitment to protect the stratospheric ozone layer in that law, to phaseout things like chlorofluorocarbons. And since 1990, as you can see from this chart, the most damaging chemicals, including CFCs, have been phased out. Our projection is that this will reduce skin cancer occurrences over the next century by 295 million.

Cleaning up cars, buses, trucks, and fuels was another important part of the Clean Air Act. The first tier tailpipe standards in the Act that went into effect in 1994 reduced emissions by 40 percent. A negotiated national low emission vehicle program that is taking effect this year in the Northeast and in the rest of the country in 2001 reduces NOx by 50 percent. The reformulated gasoline program reduced VOC and toxics by 15 percent. In the RFG areas, we are measuring over a 40 percent reduction of ambient benzene in the air.

Let's take a look at some of the specific numbers again that have been mentioned several times. Lead down, this is going back to 1970, lead emissions down 98 percent, and you can see the numbers there and I won't go into them in detail. I will note that nitrogen oxides emissions have increased since 1970, although in the last decade they have started to come down. And you have these charts. I am going fast here to try to——

Senator INHOFE. We appreciate that. Thank you.

Mr. PERCIASEPE. This hasn't happened without the strong support of a statute passed, as I mentioned, with strong bipartisan support, strong support in both the Senate and the House that was designed for success. I think, Mr. Chairman, you mentioned some of these innovative things that were spurred by the Act, the trading programs. The acid rain program for SO_2 has been a big success and continues to be a success, although at the end of my remarks I will get to what more might need to be done there. In the Northeast we are working with the States on a nitrogen oxide trading program which is a unique partnership between the States and EPA. And there have been plenty of innovations at the local level

with market mechanisms and trading, like the RECLAIM Program in California.

We have had multiple stakeholder processes. I mentioned the National Low Emission Vehicle Program. This was a process with the States and with the automobile industry to look at delivering improved performance of motor vehicles on a national level, and all the participants in that stand to be congratulated because that is happening today. The Acid Rain Advisory Committee was set up early in the 1990's to work with all the stakeholders to set up the acid rain program. The Ozone Transport Assessment Group (OTAG) for 37 States in the Eastern part of the country was established to look at state-of-the-art modelling of nitrogen oxide across the entire Eastern part of the country.

Also compliance assistance—we often lose sight of the work that has been going on in this area. In the 1990 amendments, small business technical assistance programs were established, an ombudsmen for small business for every State, just to give you an example. In 1997, there were 78,500 assistances provided to small businesses, 6,000 onsite consultations. These are examples of the kinds of things that are going on out there on a day-to-day basis. A Texas furniture company was able to invest $8,000 in a new coating technique for painting and coating furniture that dropped VOC emissions almost in half and saved tens of thousands of dollars on an annual basis. Also the Great Printers Program in the Midwest around the Great Lakes area and the printers association, strong work with them; metal finishers, strong work with the metal finishers. With the automobile industry, we have worked on a revised approach to compliance assurance called CAP 2000 which we just implemented that will save the automobile industry $55 million a year in compliance costs for all their certification programs.

This next chart brings together some of the points I think that have been made in the opening comments and that I would like to concentrate on for just a moment. The green line at the bottom of the chart shows the aggregate emissions from 1970 to just a couple years ago, pretty much present time. I think it has already been mentioned the criteria pollutants have been reduced by 30 percent from a 1970 baseline. During that time, population has gone up, Gross Domestic Product has gone up, and another indicator of our activity in national economic activity, vehicle miles travelled, more people moving around, has gone up.

While this has been happening, according to our retrospective study on public health, under section 812 of the Clean Air Act, is 184,000 premature mortalities have been avoided, 10 million IQ points have been preserved, 8 million acute bronchitis cases have been avoided, 39,000 heart failures have been avoided, 130 million instances of acute respiratory symptoms, and I could go on. That is just a summary of the health benefits that are accruing from our retrospective study.

What this has not meant to the economy? Some of the predictions we have heard already. For example, it was predicted that the acid rain program would cost up to $7 billion. Recent EPA and General Accounting Office estimates, $1 to $2 billion. Reformulated gasoline—there was testimony that it would cost 16 cents a gallon. The true cost is 3 to 5 cents a gallon. The refrigeration industry

said reducing CFCs was just not feasible. CFCs are gone, substitutes are there, a whole new industry has come up. The automobile company testified in 1980 "We just don't have the technology to do this." Today, 10 years later, they are providing technology beyond what Congress was even contemplating 10 years ago.

How did this happen? How did we have this economic growth and this reduction in pollution at the same time? We had it because we had a Clean Air Act that was designed for action, and we had it because of the innovation of American business. We continually underestimate their ability to innovate and achieve our goals in this country. That is one of the problems that I will get to in a moment when we talk about cost-benefit analysis, because we don't know what the cost is going to be because it is always cheaper than we estimate today when we actually do it tomorrow.

This is the last chart. You see this is the summary chart.

[Laughter.]

Mr. PERCIASEPE. I try to be succinct. We still have, as you heard, 100 million people still living in areas that don't meet the air quality standards. Several opening statements talked about the new standards that we have issued. Congress required EPA to look every 5 years to update standards. We did that in 1997. Implementation has been delayed by a court remand and we are appealing that.

I want to point out a couple of things because I really do disagree respectfully with the comments that science was not used in setting those standards or that independent analysis was not provided. There has been no impartial body that has disputed the scientific basis of those standards. The courts' decisions were not based on the science. They were remanded for other reasons. We can probably get into this in the questions and answers because I know I am getting near the end of my time, but we need to move forward with implementing those standards. We will continue to work with the court and the judicial system to move forward on that. We will continue to do the reassessment of some of the science that we did commit to.

But while that goes forward, there is some remaining unfinished business that we need to do. We still need regional nitrogen oxides reductions. The National Academy of Sciences told us that almost 10 years ago now and we are still fooling around with it. The next generation of tailpipe and gasoline standards, you saw that VMT chart I had up there before, there is no projection that it is going to go the other way. So, as a great philosopher once said, Will Rogers, even if you're on the right track for tailpipe emissions, he didn't have tailpipe emissions in there—you'll get run over if you just sit there. And that is what is going to happen with VMT. That is why we need to continually improve automobile and fuel technology. Heavy duty engines and diesel fuel, local measures for the 1-hour ozone standard in the severe and serious nonattainment area. Air toxics, we need to move that program into the risk-based part of it, and we need to facilitate more regional planning.

Mr. Chairman, we are prepared to work with the committee on the process that you are initiating today to review the Clean Air Act. We want to work with you to evaluate whether reauthorization

is needed or whether it will be disruptive. We think the process that you have in place to review different parts of it will be helpful to us and to you for making that decision. There are some ideas that I will throw out right here that are worth considering as we go through that process: Additional authority for multiple State cap and trade programs for any pollutant; indoor air quality is not included in the Clean Air Act; address all utility emissions including greenhouse gases; and a new generation of fuels, and more flexibility in our authority on oxygenates so that we can deal with that.

So, in closing, I appreciate the opportunity to be before you today to talk about this. You can see that there have been successes, and you can see that it has been done in an innovative way, and you can see that there are still challenges before us. So I stand here ready to answer your questions.

Senator INHOFE. Thank you, Mr. Perciasepe. I am sorry we had to be so hard on the time but it is necessary. I am going ask you a couple of questions and then I am going to excuse myself for just a few minutes because we have the Senate Armed Services Committee with Secretary Cohen. I know that Senator Lieberman has the same problem. I have to run down there just to get a couple of statements in and then I will come right back up.

Mr. Perciasepe, did you read the testimony of Dr. Graham and Ms. Kerester? Did you have a chance to read that testimony they submitted?

Mr. PERCIASEPE. I am afraid I haven't.

Senator INHOFE. Let me read a couple of paragraphs here and just kind of get your reaction. This is from Dr. Graham. He said, "Measuring success by the number of industries regulated is not very meaningful to public health. The big unknown in the toxics arena is whether the public health benefits of reduced human exposures to air toxics have been significant enough to justify the significant expenditures of Agency and industrial resources that has taken place."

And then Ms. Kerester states in her written testimony, which she will elaborate on in a few minutes, "The Clean Air Act Amendments of 1990 rely solely on the assumption that outdoor levels are determinative of an individual's exposure, and hence risk. Merely reducing the ambient emissions level may not result in improved public health."

In your testimony, you downplay the need to renew this Act. I think you said "Let me stress that once this review process is completed, we must assess whether reopening the Act would be more helpful or more disruptive on the whole." I guess you mean we should just continue on the same path, that's my interpretation anyway. And based on these two witnesses, I would question whether or not that is the right goal. Would you like to respond to that? Can you say that the current regulatory programs are the most cost-effective way to improving public health and what people are actually exposed to?

Mr. PERCIASEPE. I think those comments that you just read to me from those other testimonies relate to a very specific part of the Clean Air Act related to stationary source toxic emissions, which were not dealt with very well, if at all, before the 1990 amendments. Congress envisioned a two-step process when they set that

up. First, that in all these different industrial categories, people ought to perform on the toxic emissions profile to the best performers in that class. These maximum available control technology standards are designed to find the top performing percentage of the class, and then have everybody move into that performance level. Then after that, look to see if there is any residual risk. The second step gets into exactly what you're talking about and what I am assuming the testimony gets into, and that is: What are the remaining risks, if any, after you make those improvements.

So Congress envisioned a two-step process. We are prepared to go to that second step to look at what residual risk is out there in the environment in the ambient air from toxics and attack only those risks that are meaningful from a public health perspective. I would agree that we need to move on to that level of analysis and work. We are moving to that point now at the Agency. It seems to me that is what the Act had set up the process to do.

Senator INHOFE. Let me just read to you another statement from Dr. Graham. I know Dr. Graham and Ms. Kerester are here and we might ask them to listen to the response.

Dr. Graham said that "The EPA has not modernized its cancer risk assessment guidelines to account for advances in biological understanding of the mechanisms of cancer induction." And he goes on to discuss specific examples of where the EPA has been lax on science issues. I am very concerned that you are starting down a major regulatory program, the Air Toxins program, without first completing the necessary guidelines or paying attention to the most recent science. Dr. Graham asked Congress to pay attention to this issue, and I am. I would just like to get your response to that, and then my time has expired and I will have to excuse myself.

Mr. PERCIASEPE. Well, I agree with the comment about the cancer guidelines. We are pushing hard in the Agency to get those cancer guidelines updated. We are ready to use the updated guidelines when we're finished with the process review. We are doing that now.

Senator INHOFE. Thank you, Mr. Perciasepe.

Senator Baucus?

Senator BAUCUS. Thank you, Mr. Chairman.

Mr. Perciasepe, as you kind of stand back a little bit and think about the Act, I wonder if you could just embellish a little bit on your presentation; namely, where has it really worked, where, as you're driving to and from work and think about all these things, do you think we should perhaps concentrate a little bit. But just your overall assessment of all of this, just standing back a little bit for maybe some perspective, and just flesh out a little more on what you just said.

Mr. PERCIASEPE. Any of these environmental statutes—and, as you know, I have had some experience on the Safe Drinking Water Act and the Clean Water Act side as well—all of these work best when everybody works together toward a common goal. That was the hallmark of the enactment of the Clean Air Act early on in this decade. The Clean Air Act processes that attacked pollution by fostering emerging technology. For example, the Act addressed air pollution caused by the automobile by looking at fuels and cars as a system and by working with both the oil and automobile indus-

tries together. The Act has set up those processes. Another example is our working with the utilities on market approaches and putting a goal in place, a declining cap to allow market mechanisms——

Senator BAUCUS. Where in the Act has working together worked best, and where in the Act, or maybe not in the Act, has there been not enough working together?

Mr. PERCIASEPE. Well, I guess I would fall back on the examples I used, Senator. Clearly, working together on the acid rain program has worked. It is not just the natural resource managers who are concerned about acid precipitation, not just the utilities, not just EPA, not just the States, but also the commodities markets in Chicago who have been involved. So, it is a really broad-based involvement toward a common goal.

I think we have an effective system there. It is time to evaluate whether or not the goal that Congress set of a 10 million ton reduction is adequate to achieve the objectives that the Act set out for actually preserving the natural resources and the parks of the country that are severely impacted by acid rains. I think you will have some more testimony about that. But you can use existing mechanisms to allow that process to continue.

Senator BAUCUS. You made a very good point that we always over-estimate the costs. Could you give us some examples of that and flesh out a little more as to why that happens. I think that is a very valid point, one I agree with. For example, I recall that years ago when Congress asked the auto industry to come up with a catalytic converter they said "That's impossible. It can't be done." We told the industry to do it anyway. Well, guess what? They did it. Not only did they do it, they did it in a way in redesigning their emission systems so that it is much more cost-effective and they made money on the deal. But if you could just give us some examples of just where we really overshot the costs and how the innovation, ingenuity of America's business people have found through developments in new technologies lot cheaper ways of doing things.

Mr. PERCIASEPE. I think the example you give is a very good one, the automobile. I want to say this right up front, that progress and improvement would not have happened without the tenacity of the automobile industry to do the engineering and the innovation that needed to take place. At first, there is often resistance to change, but once you're there, the innovation comes. And that is what we see every time. Reductions in automobile emissions are a classic example of this.

I remember in the early 1990's when I was working in the State of Maryland trying to opt in to the California low emission standards. I needed lower emission vehicles in Maryland; they were being delivered in California and I wanted them too. This was an opportunity that the Congress provided in the Act. The debates I had were how many thousands of dollars this was going to cost per car. I testified in the Maryland General Assembly alongside my colleagues in the automobile industry, I'm saying hundreds of dollars, they're saying thousands of dollars, and we know what the true cost was. I have personal experience with such resistance.

I don't want to make it sound like the industry doesn't step up to the plate. They do, and they did, and that is what makes some of this very difficult to deal with in terms of projecting into the fu-

ture what these costs might be. It is not only achieving the goal at a cheaper cost, sometimes we find out we can do better on the goal at the same cost. So, both of those come into play when you look at the innovation that takes place.

To the automobile industry's credit also, and the oil industry's credit, they have come forward and said we need to look at these two things more as a system and we can even get more forward. So we take that next step. We said how does this work together——

Senator BAUCUS. My time has expired, but if you would indulge me just one followup question. Any advice you have as to how to get the players together earlier to better work together so we would have less problems trying to cross that threshold? I agree with you. Once the industry starts, they do a bang up job. They're great. But it's that point of realizing that we have got to go this next step. Any thoughts as to how we get the industries, the EPA, and folks together earlier on in the process to say, hey, yes, this is good for business, this is good for the environment, this is good for our company, let's figure out a way to do this?

Mr. PERCIASEPE. Human nature is that when you are faced with a challenge you rise to the challenge. That has been what makes this country great. People do it. What end up tangling ourselves in these arguments over whether the cost worth it or not. That shouldn't be the argument. The argument should be how do we innovate to achieve it. One example of the difficulties associated with evaluating public health is using cost benefits to ozone. If you use a cost-benefit analysis between 0.09 parts per billion of ozone and 0.07 parts per billion, or 0.08 parts per billion, you will soon recognize the limits of the tool. With the tools we have, that is like using a sledgehammer to do a staple job.

The tools we have on cost-benefit analysis cannot give you any information as a decisionmaker between 0.09 parts per billion and 0.08 parts per billion. The sensitivity does not exist. We don't know how much we will be able to reduce the costs in the future when innovation takes place. It is just a futile exercise in setting an air quality health standard. It is not a futile exercise to consider cost in determining how you would implement that goal. In implementing, we must look at costs, we must figure out how we distribute that in the economy, and what timeframes are provided to allow that innovation to take place.

Senator BAUCUS. My time has expired. I want to thank you very much.

Senator VOINOVICH [presiding]. Senator Lieberman?

Senator LIEBERMAN. Thanks, Mr. Chairman.

Very briefly, some of the testimony today suggests that EPA's commitment to cost-benefit varies widely and that the Agency sometimes estimates regulatory costs but does not quantify benefits in health or economic terms. I wonder if you could describe briefly how EPA considers costs and benefits in setting standards, and how it considers costs and benefits in implementing them.

Mr. PERCIASEPE. Some of that, as you say, does vary from statute to statute, and from parts of the statute to parts of the statute. When we look at setting health-based goals and standards, we want to use science to tell us the polluting level associated with the

health effect from which we're trying to protect the general population, or for that matter, susceptible populations or concentrations of populations in urban areas. The cost-effectiveness kind of analysis you would do in considering, for instance, nitrogen oxide reductions from power plants, can be a much more refined cost and effective analysis. You can look at specific technologies that are in existence now, you can make some judgments about where those technologies might be in the near term, and you can do a good analysis.

So, we have executive orders that tell us to calculate these costs and the benefits. We do the retrospective study in the Clean Air Act that Congress has requested under section 812, and we are in the process of doing the prospective study which we hope to have out later this fall. So these tools are useful and they can help inform everybody of where we're going.

But when looking at the health-based standards, we're telling the American public what the level of pollutants are in the air that are going to be healthy for them. If then you say, ''Unfortunately, our current ability to do cost-benefit analysis tells us that we're not going to make it at that level.''—I don't think that is what Congress had in mind.

We have had 25 years of the Clean Air Act where we have set standards without doing that. We have had six different presidents, we have had 15 different Congresses, and we have never considered costs in trying to tell the American public—which I think was a covenant that Congress made with the American public when they enacted the Clean Air Act—that this is what healthy air is.

When the science gives us more information about that, we reset the standard. The time limit to achieve the standard, to allow the innovation to take place, the diversity of methods, whether it be trading or technology-based standards, all of that needs to be looked at in how you can most optimally achieve those health standards. I am sorry I have gone on so long.

Senator LIEBERMAN. No. I agree. I enjoy your passion. Let me ask one more question just to delve a little bit more into perhaps the other side of the cost-benefit analysis, and it goes back to something I said in my opening statement. What are the current ways that the Agency tries to quantify and predict technological innovation and market trends when evaluating the costs of a given air quality objective?

Mr. PERCIASEPE. We do it through a number of ways. First, and foremost, we are increasing our relationships with the business community that is out there doing the innovation. I could have put a chart up here, which I didn't, on the amount of the GDP that is related to pollution control work—the amount of innovation and business activity involved with innovating in pollution control and pollution prevention. I believe that product design is going on at a more robust level in the United States than I think it ever has in the past. The pollution control and preservation industry is out there for us to engage with and get their views on where they see some of the innovation going.

We also do our own research and development. We have an Office of Research and Development that looks at technology for different areas, and their work helps inform us on the future. Many parts of the Clean Air Act and some of the other statutes, when

we're looking at specific technology-based standards for a particular class of sources, require us to look at feasibility. In some cases, we actually will develop a prototype ourselves. In our Ann Arbor, MI, lab where we test all the motor vehicles, we actually will take a sport utility vehicle. We will work with catalyst manufacturers, engine control technology, software folks and we will develop an optimized emission control system on that vehicle to see if it is feasible to achieve certain pollution levels. So, sometimes we actually will do the research ourselves.

Senator LIEBERMAN. Do you think we are in a better position today than we were in 1990 to fit into our cost-benefit analysis the cost of technological innovation than we were then? I cited some of the estimates, and most of the estimates were over-stated, or a lot of them were.

Mr. PERCIASEPE. Only on a near term. It is hard to get too far out. Again, just 9 years ago we were thinking some of the things we can do with automobiles now would be thousands of dollars per vehicle compared to hundreds of dollars per vehicle. On a coal-fire power plant, we thought getting the kind of nitrogen oxide reductions that are technologically feasible and cost-effective now were not even feasible or will in some infant level of discovery. Innovation is happening at a rapid pace. It is hard to predict. Oftentimes, once the air quality standards are in place, a lot of innovation occurs on how to achieve it more cheaply. Predictions for costs further out in the future become less certain.

Senator LIEBERMAN. Thanks, Mr. Perciasepe. And thank you, Mr. Chairman.

Senator VOINOVICH. You're welcome.

Mr. Perciasepe, first of all, I think that the record of achievement is very impressive. I would like to add, and I am glad you mentioned it, a great deal of it is attributable to the aggressiveness of many of the industries and political subdivisions in this country that are interested in having clean air. I know in our State, we have about 160 of our worst polluters agreeing to reduce their 17 worst toxics and have made some real progress there. Every year we honored individuals that had done a good job in the area of air pollution. It also showed that by doing it, it was not only good for the air, but good for business. So there is a lot of good things going on there.

A couple of things I would just like to comment on and maybe get your reaction. As you know, I am particularly concerned about the NOx SIP call. You were saying that the Agency likes to involve people in the decisionmaking, a partnership. I just want to point out that the OTAG organization, when they were talking about complying with that SIP call, fundamentally said that they felt that the States should try to work out a reasonable way of complying with this. And, as you recall, it was 85 percent or 65 percent. Your Agency just ignored the OTAG recommendations and put an 85 percent requirement on our utilities when the Midwest Governors and the Southern Governors had indicated that going to a smaller amount could get the job done, and, in some instances, would have gotten it done before the 85 percent requirement that your Agency put on them.

I just wonder, you talk about cooperation and working with people, what is your reaction to that?

Mr. PERCIASEPE. First of all, I appreciate those comments. There were some tough decisions that had to be made in that process. But let me address the things that we did agree on, and then I'll get to your point at the end.

Senator VOINOVICH. And by the way, that was all meant to try and reach the new 8 hour ozone standard.

Mr. PERCIASEPE. I'll mention that too at the end. The OTAG process was precipitated by many things. One of the things that precipitated it—and it was going on before the 8-hour standard—was the realization in the scientific community that for levels of nitrogen oxides, regional reductions are going to be almost as important as some of the local VOC reductions to meet the ground-level ozone standard. And so a lot of work was done on that in the early 1990's which then facilitated this 37-State Ozone Transport Assessment Group to look at the most up-to-date modelling.

I think it is important to note that I believe all 37 States agreed that significant regional reductions in nitrogen oxide were appropriate for the benefit of all, and that they agreed on a range of what it ought to be. And you are right, we picked the more exemplary end of that range. And we all agreed that in implementing whatever that budget would be for each State, that the proper approach would be to give the State the flexibility on how to achieve the budget. So we set up a process where each State would have a budget, similar what we have tried to do in the acid rain program. We would have banking and trading, early credits, and all of the market mechanisms in place to reduce the cost of the rule. Then the State would have some flexibility in its own planning processes to figure out the best way to achieve the targets. We identified an approach we thought would be very cost-effective.

One of the things that started to evolve there, Senator, was, again, these very different cost estimates; how much is this going to cost to achieve these reductions. We had a set of cost estimates for measures that we think are very cost-effective and there were others who had different cost estimates. This became a tug of war of the cost estimates.

Senator VOINOVICH. I understand that. All I am saying is there was an agreement that we would have flexibility and we didn't have it. And that bothers me.

The other thing is that you talk about good science and that that is taken into consideration and how you measure that. The fact is, when you went with the new PM standards, from 10 to 2.5, you still don't know the real impact of what 2.5 means as compared to 10 in terms of public health. When you proposed that new rule, at the same time you proposed it the Agency asked for I think $37 million from Congress to do research work on the PM standard. Last year, it was some $60 million, and I think you are asking for more this year.

The question I have is, instead of moving forward with that new standard in PM, and by the way, that is being held up in court today, why didn't the Agency first do their homework and get the science before they went forward with that new standard?

Another example is we were one of the States that really took on the emissions testing program. And I, you have heard me say this before, I caught all kinds of hell from my people as a result of doing that. People said it doesn't do any good, and I said yes, it does do good, and we are given credit for it and it is helping us meet the required ambient air standards so we can come into compliance with the standard. But when I went back to the Agency to ask them can you tell us just how these emissions testings help clean up the air, we could not get an authoritative answer from you. As a matter of fact, we had to go to Congress. Dave Hobson I think asked for $350,000 to do a study in terms of whether or not this emission testing was, indeed, making any difference in terms of reducing the pollutants. I don't know where that study is today, maybe you do. Where are we on that?

Mr. PERCIASEPE. Let me do the PM first. We went through a vigorous scientific process with our Clean Air Act Scientific Advisory Committee to look at fine particles. I know of no scientific disagreement that the smaller particles are more important for public health protection than we had thought in the past and that regulating a smaller-sized particle is appropriate.

Senator VOINOVICH. The fact of the matter is that smaller is better. In terms of real impacts on public health or impacts on the costs to comply with the standard, which are significant, it was just said, "Well, it is going to make things better. How much better we don't know; we know it is going to make it better, although some scientists have some questions about that." It just seems that when it comes time for decisionmaking in the Agency, instead of using what I call common sense, it always falls on the side of: "Let's go ahead and do it, we're not really sure about it, but, sure, it's going to be better."

Mr. Chairman, just one last thing. I'll never forget this as long as I live. Lorain, Ohio, this is before the Clinton Administration, Lorain, Ohio, U.S.S. Colby wants to put on a brand new blast furnace and shut down an old blast furnace. The Environmental Protection Agency said they couldn't do it because the new standard that they had set—and, by the way, the new standard they had set for the ambient air standards in Lorain had been set when that steel plant was almost out of business. So now they're coming back, they want to put on a new blast furnace, take down another one, clean up the air, and the Agency says you can't do it. I had to go to Dan Quayle, who I think was head of the Cabinet Council or something like that, to finally get that thing worked out.

What I am saying is that it is the common sense, it is the balance that just doesn't seem to be present. I think, and this is just a recommendation in terms of using risk assessment in the air standard that basically is in the Safe Drinking Water Act, that kind of thing is necessary in order for the Agency to function in a reasonable fashion and encourage people to spend money where it is going to make a difference and not get them involved in things where they are going to spend money and not get a return on their investment and don't make a difference in terms of a public health.

Mr. PERCIASEPE. I will just say something generally.

Chairman INHOFE [reclaiming the chair]. And make it fairly brief because we are going to have to move on to the next panel.

Mr. PERCIASEPE. I just want to say for the record that with all the possible respect I can muster up here, which is a lot for both of you, I disagree with your characterization of how the Agency makes decisions. I strongly disagree with them. The Agency went through a very deliberative process. We didn't just sit there and say, ''Well, what the hell, it will be better if the particle size is smaller.'' That is just disingenuous. We thoroughly reviewed the available science. It went on for years. We have committed to reverifying the standard before it gets implemented and that reverification process is underway. We committed to have a very robust monitoring program in place, which is why we are asking for the funding.

Senator VOINOVICH. But you put the standard out and you are going to say to the communities that you haven't met the new ozone standards, you haven't met the new particulate standard, and you place this designation on an area. You have no idea of the impact that has in terms of keeping businesses in the area and getting them to expand and of businesses coming to the area. One of the reasons why I wanted to obtain ambient air standards in Ohio was to get that negative off communities, because businesses around the country told me that if they aren't reaching their ambient air standards, we are not going there, we're going someplace else because we don't want the headaches. A couple of businesses were talking about leaving the Toledo area, Cooper Tire was one, because of the fact they had not reached the ambient air standards and they were told if you don't reach it is going to cost you a whole lot more money if you're going to expand.

So when you start giving these designations in communities around the country, those designations have tremendous impact on the economic vitality of those communities. So I think it is important that we're careful about going forward with some of that.

Senator INHOFE. I am going to have to exercise the prerogative of the chair and regain control.

[Laughter.]

Mr. PERCIASEPE. We can continue after the hearing.

Senator INHOFE. We thank you very much, Mr. Perciasepe. I am sure you will want to answer some things for the record, and you certainly may do that. So we will excuse you now.

Senator INHOFE. We would ask for our next panel to come forward. We have Professor John Graham, Harvard Center of Risk Analysis; Professor Richard Revesz, New York University School of Law; and Ms. Alison Kerester, University of Texas School of Public Health, Mickey Leland National Urban Air Toxic Research Center. We welcome you all to this committee. We will ask that you watch our little stop/change/go lights and comply with that since we are under some time constraints here.

Let's go ahead and start with you, Ms. Kerester.

STATEMENT OF ALISON KERESTER, UNIVERSITY OF TEXAS SCHOOL OF PUBLIC HEALTH, MICKEY LELAND NATIONAL URBAN AIR TOXICS RESEARCH CENTER, HOUSTON, TX

Ms. KERESTER. Thank you very much. Good morning. I am Alison Kerester. I am the executive director of the Mickey Leland National Urban Air Toxics Research Center. The Leland Center was

established by Congress under Section 112 of the Clean Air Act as a public/private partnership to sponsor research on the public health impacts of air toxics. Congress created the Leland Center to generate the critical information needed to make air toxics health risk assessments more realistic.

In keeping with our congressional mandate, the Center identified two critical information gaps: One, personal exposure to air toxics, and two, the non-cancer effects of these exposures. The Center chose to focus its initial efforts on personal exposure, and that is what I am going to talk about this morning.

Exposure is defined as the contact of a chemical, biological, or physical agent with the boundary of the body over a period of time. People may be exposed through inhaling a chemical, through ingesting it through food or water, or having it absorbed on the skin. For air pollutants, inhalation is the primary route of exposure.

What people are exposed to is a function of where they spend their time, how much time they spend there, and the activities they engage in. People move through a series of locations or microenvironments during the course of the day. This room is a microenvironment, my time in the plane last night is a microenvironment. Studies have now shown that Americans spend the majority of their time inside, and in some cities, such as Houston, that amounts to almost 90 percent because of climatic conditions.

Scientific research has demonstrated that indoor sources may often be the dominant source of air toxics exposures to people. While outside sources can penetrate inside through ventilation systems and open windows, air toxics may be emitted directly from sources in the home or building through carpeting, building materials, consumer products such as room deodorizers. In addition, the simple activity of cooking or even taking a shower may generate air toxics. In some instances, outdoor air sources may be the primary source. For example, carbon tetrachloride has been banned from consumer use; however, it still exists in the ambient air. Thus, the source of exposure to this chemical would be an outside source.

In addition, some emissions in a person's breathing zone may contribute significantly to personal exposure while contributing a minimal amount to ambient levels. Smoking is an example of this. Smoking accounts for the largest percentage of a personal exposure to benzene, yet that activity contributes a minimal amount to ambient levels. Thus, it is important to take into account all sources of potential exposure and to understand the relationship among outdoor, indoor, and personal exposures. There are a number of scientific studies underway investigating this relationship.

Exposure assessment is the science of measuring people's exposure. It can be done by a variety of methods. The more accurate the method means it is closer to the body. So breath samples, and the use of a personal monitor, which is being used in several studies, attached to the lapel, picks up chemicals within a person's breathing zone. Exposure assessments are used in epidemiological studies, they are used in risk assessments, in trends analysis, and in risk management decisions.

The protection of public health under the Clean Air Act is at the core of the Act. However, the traditional approach under the Act is to equate ambient air concentrations with adverse health effects.

However, it is actual exposure, and not air concentrations, that is the critical factor in determining potential adverse health effects. Exposure is the link between ambient concentrations and human health impacts. If we focus on exposure rather than just on ambient numbers, we will gain a much greater and more accurate picture of public health impacts. Continued reliance solely on ambient numbers may not produce a corresponding benefit to public health.

So we believe it is important to continue our exposure research, and the Leland Center will continue to pursue this area. Thank you.

Senator INHOFE. Thank you, Ms. Kerester. I think you all understand that your entire statement will be made a part of the record.

Ms. KERESTER. Yes.

Senator INHOFE. Dr. Graham.

STATEMENT OF JOHN D. GRAHAM, DIRECTOR, CENTER FOR RISK ANALYSIS, HARVARD SCHOOL OF PUBLIC HEALTH, BOSTON, MA

Mr. GRAHAM. Thank you, Mr. Chairman. It was about 10 years ago that I first testified before this committee on President Bush's proposal to amend the Clean Air Act, a proposal that was expanded into what we now call the 1990 amendments to the Clean Air Act. We have learned a great deal during that process. You have heard some of the good news.

First, the total benefits of the 1990 amendments appear to be greater than the total costs. But it is important to remember that virtually all those benefits are packed into just two of the provisions of the Act, the sulfur trading program, and the chlorofluorocarbons parts of the Act. A lot of the rest of the Act flunks a cost-benefit test by the kinds of numbers that the Agency is producing.

Second, that grand experiment with incentive-based programs, the sulfur trading, that explains why a lot of the cost estimates that were originally made were so far off, because we have given strong incentives in the market economy for people to trade and find the least-cost ways of achieving these results. It is very important to keep that in mind because a lot of people were opposed to those market-based instruments, said they would never work, would never clean up the air, and those incentive-based programs have, in fact, been quite effective.

I would like to focus my testimony on five problem areas in the Act that I want to encourage the committee to investigate further during this process of reauthorization.

Problem 1. Some provisions of the Clean Air Act are unworkable because they do not require or permit EPA to weigh risk, costs, and benefits. A concrete example, as Senator Voinovich has given, is the primary ambient air quality standards. The basic idea was to set this level of pollution in the air so that it would protect public health with an adequate margin of safety.

The problem is scientific information alone cannot identify such a level for many of these pollutants. Indeed, the only safe level of exposure to many of these pollutants, fine particulates and lead, given current science, would really be zero. As a result, the only logical conclusion would be to set the standards at zero. However,

obviously, it is not realistic or feasible to set them at zero. So EPA, therefore, is forced to construct imaginative, spurious explanations for what numbers they come up with to define the safe level of concentration in the air. This dishonest process contributes to an atmosphere of arbitrariness, mistrust, and litigation that we have already discussed this morning.

It seems to me Congress could make a constructive step in this process by either authorizing or requiring EPA to consider whether the incremental costs of an air quality standard are grossly disproportionate to the anticipated benefits of the proposed standard.

Problem 2. Although Clean Air regulations are intended to reduce risk to public health, they sometimes cause unintended dangers to public health because the risks of the regulation are not analyzed carefully by Congress and EPA when policies are made. A good example that we're all aware of right now is the requirement in the 1990 amendments to increase the oxygenated content of gasoline. It was done without preparing a careful risk-benefit analysis. I am not talking about the cost side; I am talking about the human health and ecological implications of this requirement. The most important chemical used to comply, MTBE, is now showing up in surface and ground water, and questions are being raised about whether it was such a good idea in the first place after all.

This is a good example of where Congress should insist that both itself and EPA take the hippocratic oath that physicians take. We should make sure that we have enough science behind a decision to, in fact, be assured that we are doing more good than harm with a clean air regulation.

Problem 3. Congress and EPA sometimes pursue clean air goals without taking account of national objectives, such as energy policy. In my written testimony, I give you the example of the diesel engine which is being encouraged in Europe today and discouraged in the United States, with difference consequences for global warming.

Finally, I make detailed comments, that several Senators have also quoted, on the lack of public health science behind a variety of these regulations. And I look forward to the comments and questions.

Senator INHOFE. Thank you, Dr. Graham.

Professor Revesz?

STATEMENT OF RICHARD L. REVESZ, DIRECTOR, PROGRAM ON ENVIRONMENTAL REGULATION, NEW YORK UNIVERSITY SCHOOL OF LAW, NEW YORK, NY

Mr. REVESZ. Thank you, Mr. Chairman. I would like to discuss a number of issues concerning the possible use of cost-benefit analysis under the Clean Air Act.

As you know, the primary benefit of many environmental statutes is the number of human lives that are saved as a result of environmental regulation. There is general agreement that the starting point for obtaining a value for life for cost-benefit purposes is by reference to the wage premiums that workers obtain in jobs that entail a risk of instantaneous death in industrial accidents. Though the value of life figures that are obtained in this manner need to

be adjusted upward to obtain a meaningful valuation of the benefit to environmental regulation, for several reasons.

The first reason is that the risk assumed by individuals who subject themselves to possible industrial accidents is a risk that is assumed voluntarily. In contrast, the risk of exposure to environmental contaminants like air pollutants is assumed involuntarily. There is an extensive literature showing that individuals assign greater value to avoiding risks that are thrust upon them involuntarily than to risks that they incur voluntarily.

On a related matter, valuations derived from the study of risky jobs are the valuations of a relative small subgroup of the population with a disproportionate tolerance for risk, because these are the people who fill the jobs at the smallest wage differentials. But for environmental policy, what matters is the valuation of the median individual and not the valuation of an individual with a disproportionate tolerance for risk.

A second set of upward adjustments is necessary is because individuals who take risky jobs generally have lower than average income. And there is also consensus among economists that the valuation for life that derives from these techniques is essentially a function of income. Given the median incomes of workers in risky occupations and the population as a whole, an upward adjustment in the value of life is necessary if one makes regulation for the population as a whole.

A third point is that with respect to some contaminants, like carcinogens regulated under section 112, an upward adjustment needs to account for the dreaded nature of the harm as opposed to the case of simple instantaneous death, because in addition to the loss of life itself, one needs to value two other components: the very painful and often extended period of morbidity that precedes the death, and the dread aspects of cancer itself.

Some policy analysts have suggested a downward adjustment to the value of life obtained in workplace studies must be performed in certain instances to account for the fact that the beneficiaries of certain environmental programs are older individuals who have shorter life expectancies and that these individuals sometimes are not in good health. These analysts argue that the remaining life expectancy of older individuals should be multiplied by a value for a life year, and they obtain a value for life years by assuming that workers who take risky jobs and are relatively young value each of the remaining years the same amount.

This methodology assumes that the value of a life year is the same regardless of one's remaining life expectancy. Thus, it overlooks a critical aspect that scarcity plays in determining economic value, which implies that individuals will value life years more highly when they have fewer life years left.

The use of values for quality-adjusted life years is also generally inappropriate. The measure of benefits in cost-benefit analysis is derived from the aggregation of the willingness to pay of all of the individuals affected by a policy. The QALY technique, the quality-adjusted life year technique, in contrast, relies heavily on the assessment of third parties, sometimes health individuals and medical professionals, of how undesirable a life in poor physical condition is relative to a healthy life. As a result, the QALY rankings

generally have no connection to individual willingness to pay and, therefore, cannot properly be incorporated into cost-benefit analyses.

For many environmental contaminants the harm does not occur contemporaneously with the exposure. And for such latent harms, it has been the policy of the Office of Management and Budget, in its review of Agency regulations under Executive Order 12866, to apply a discount rate to reflect the fact that the benefit of regulation does not accrue until the future.

OMB currently uses a discount rate of 7 percent. As explained in more detail in my written testimony, there is a general consensus among economists that this rate is too high and that an appropriate rate is somewhere in the 2 to 3 percent range. In fact, the 2 to 3 percent rate is the rate used by both the General Accounting Office and the Congressional Budget Office in running their projections. The OMB approach leads to substantial undervaluation of the benefits of human life. So environmental benefits that OMB determines to be $100 million, if they involve a harm that has a latency period of 20 years, should, in fact, be $236 million. They are off by more than a factor of two.

And last, let me mention that in the past, and in OMB's administration of cost-benefit analysis, this technique has been coupled with procedural devices that have often turned into an anti-regulatory tool or threatened to turn into an anti-regulatory tool as opposed to a tool designed to make regulation more rational. I will just list four devices.

First, cost-benefit analysis is typically invoked only to justify the adoption of regulations, not to justify the repeal of regulations or to justify the failure to adopt more stringent regulations. Second, in OMB's administration of this technique, there is often limited disclosure of communications between the public and OMB. Third, some of the cost-benefit bills that have been introduced in Congress since 1985 contain judicial review provisions that provide for review prior to the promulgation of regulations, which would have been, I believe, a recipe for paralysis in the regulatory process. And fourth, some of these bills contained a petition process coupled with judicial review under which previously enacted regulations could be challenged. And this also, if it is not done carefully, will be a recipe for regulatory paralysis. Thank you very much.

Senator INHOFE. Thank you, Professor. Let me just pursue that a little bit. You raise some interesting points regarding the calculating of benefits based on what people are willing to pay. An example you used in your written testimony is radon gas versus pesticides, not really the best example when you think that it's an invisible gas as opposed to something that people eat.

I think there are additional limitations that you don't mention. First, people say that they will pay more to protect the environment, and yet when given the choices after extensive advertising campaigns on using premium gas for environmental purposes, they always opt out to buy regular unleaded almost every time. Second, when people feel removed from the costs of these things, they assume that somehow big business is paying for this, not realizing that is passed on to the ultimate consumers. I think that these new standards probably would have had the effect in Oklahoma, we cal-

culated on the ozone and PM standards, to raise the utility rates in Oklahoma by about one-third. Since we don't have unlimited resources, wouldn't it make more sense to prioritize our regulatory decisions basing them more on exposure than a risk-risk analysis?

Mr. REVESZ. Well, my suggestions went to how cost-benefit analysis should be conducted appropriately. I was not here to advocate the cost-benefit analysis be conducted or to oppose that. It seems to me that the unit for cost-benefit analysis is an individual willingness to pay. Unfortunately, we can't measure directly what we would like to know. So we have to deal with proxies, and we generally agree that the proxy to start with is by reference to the wage premiums individuals take in these risky jobs. Then the question is, how do you adjust that to make it relevant for what we are trying to regulate?

Now, I certainly agree with you that contingent valuation studies where individuals are asked how much would you be willing to pay to do this or that are not ideal, and that is why economists generally prefer to do revealed preference studies where they actually look at what people do in the marketplace. For example, what wage do you demand to take these risky jobs, and then from that derive an implicit valuation.

But, unfortunately, there are some areas in which contingent valuations are the only way to go because there is no other way to measure what we want to measure. I think, like everything else, there are better contingent valuation studies and there are worse contingent valuation studies. And, obviously, if we are going to base a regulatory program on these sorts of valuations, we have to do the better ones.

A number of years ago NOAA empaneled a blue ribbon panel of economists, chaired by Kenneth Arrow, who is a Nobel Prize winner, to help NOAA decide whether contingent valuation studies could be used in the context of natural resource damages. The panel was somewhat skeptical, but, in the end, gave contingent valuation a cautious endorsement, saying it was the best we could do at this point, and we should do it as well as possible. And it had some blue prints for how to do it better. That is what I believe we should be doing.

Senator INHOFE. All right. Thank you.

Ms. Kerester, when Senator Lieberman was making his opening statement, he was talking about the asthma rates are up due to smog. Now you referred to the indoor air. During the $PM_{2.5}$ debate, the effective indoor air was raised by scientists but it seems to me it was ignored by the EPA. When you state that indoor exposures are important, are you just referring to chemical exposures, or particles as well? I think they were talking about dust and cockroach droppings and a number of other things, too. What is your feeling about that?

Ms. KERESTER. Well, both indoor and outdoor sources are important for both air toxics and for——

Senator INHOFE. I mean, what percentage of time does the average person spend indoors as opposed to outdoors?

Ms. KERESTER. Almost 90 percent in many cases. People spend the majority of their time in the inside locations.

Senator INHOFE. Did you agree with my statement that it appears to me, from going through this thing, that the EPA was almost entirely concerned with outdoor as opposed to indoor?

Ms. KERESTER. That is my understanding, yes.

Senator INHOFE. And real quickly, Dr. Graham, you heard the responses to some of the quotes that I hope I was accurately quoting you from your written testimony. Do you have any comments to make about that?

Mr. GRAHAM. Yes. First, I was pleased to hear the agreement with the concern that was raised about where the Agency is in updating the scientific content of its cancer guidelines. This was a process that began in 1988 and there are repeated assurances that we're working on it, we're continuing to look into it. But it is a process that has been I think very unfortunate, because it sent a signal in the scientific community that the Agency isn't necessarily that interested in modernizing their scientific cancer risk assessment guidelines.

A concrete example of that is occurring right now with the chemical chloroform, where though this chemical causes tumors in animals at very high doses, there is good biological science suggesting that at very low doses of human exposure those tumors would not occur. EPA scientists recommended this science be used, but then that was overturned, and it now looks like we are, in fact, not going to have that biological information included in EPA's process.

So I think it is very important for this committee to put heat on the Agency to make sure they incorporate science into their risk assessment processes.

Senator INHOFE. You heard Senator Baucus when he talking about that, and I agree with that. I do want to see that there is a place for science. One of the things that I have wanted to do, and I have talked to Senator Voinovich and others about this, we have in place in our statutes CASAC, the Clean Air Science Advisory Committee, and then we have others dealing with things other than air, and I would like to see them more involved in the initial process, prior to the time that a rule comes out, so that we have the benefit at that very early point of the science that is involved in the suggested rules. What are your thoughts about that? Any of you.

Mr. GRAHAM. I certainly agree with the general principle that you want to get scientific peer review involved early in the process of an agency's deliberations. One of the points Professor Revesz made, which I think is a good one, is that having an agency like OMB very late in the game trying to do review, oftentimes with only economic expertise and with no biological or chemistry expertise, you are not setting up a very effective peer review process for agency risk assessment and for agency decisionmaking. So more peer review by the scientific community, and scientists with different disciplines, early in the process I think is much more likely to produce sensible regulation than counting on OMB to pull fixes at the last minute.

Senator INHOFE. Any other comments?

[No response.]

Senator INHOFE. Senator Voinovich.

Senator VOINOVICH. Ms. Kerester, I testified before this committee when they were considering the ozone and particulate standards, and there was a mayor of a Texas city that was there and she was asthmatic and talking about the fact that the stuff inside of her house had more of an impact on her asthma than the air outside. Is there any way that you think, if we said the reason why we have these goals and these standards is to protect public health, that you could work in some provision that says that if we conclude that the problem is more internal than external, and of course we have more control over the external because we can do that on a national level, but of making recommendations to local political subdivisions. For example, and I am not being facetious, but we concluded that we might be able to do more about asthma in some of our inner-cities by strict code enforcement, and even some suggested buying air conditions, than we could going to new standards that would require enormous expenditure by businesses and political subdivisions.

Ms. KERESTER. There may be some just relatively minor steps or recommendations that EPA could make to the public. For example, airing out clothes that you bring home from the dry cleaner, letting those air outside before you bring them into the home; venting out the home, opening the windows and bringing in some fresh air. Those are kinds of relatively minor examples. For children with asthma, it may be using a particular kind of vacuum cleaner or altering the products that are used in the home.

Senator VOINOVICH. It seems to be that part of it is being ignored and it seems that perhaps that ought to be taken into consideration when they are dealing with a problem that is of concern to all of us, to make some rather practical recommendations that might do a whole lot more to help asthmatic people than their proposed ozone and particulate standards.

Dr. Graham, critics of risk assessment and cost-benefit analysis contend that such analysis would elevate cost in a way that would value dollars over lives and the health of citizens. I would like you to respond to that. We keep hearing that those of us that are interested in good science and risk assessment are less concerned about human life than those that aren't.

Mr. GRAHAM. Senator Voinovich, I think it is a good issue to raise. The first point I think we should keep in mind is that the economic welfare of a family, the income of that family and its wealth position, the employment status of the mother and father in that family, they have a powerful impact on the human health of both the parents and children in that family. We should not underestimate the importance of the material well-being of the household in influencing their health.

The examples that you gave in the State of Ohio, when a region of a State is declared to be in nonattainment and businesses don't expand or come into that community, that is not only an economic issue, that is a public health issue for the parents and children in those families. So I think we should not draw this sharp separation that public health is over here and economics is over here. The two are, in fact, very intimately tied. So I think we do have to bring some discussion of the economics into the Clean Air Act.

Senator VOINOVICH. I will never forget running into a woman in Steubenville, Ohio, she was an immigrant, and she said I remember when the air was dirty and I put the clothes out and they got soot on them. And she said now the air is cleaner and nobody has a job. Some of those considerations, that is an extreme example, but the fact is that if your economic condition is lessened in a community and people are unable to have a job and are not able to buy health insurance, for example, or they don't have a job that provides health insurance, that has I would think a more substantial impact on their well-being than does the standards for ozone and safer particulate matter.

Mr. GRAHAM. Senator Voinovich, I think the example you are giving is not just hypothetical or anecdotal. In my written testimony, I describe one of the examples of the regulations under the Clean Air Act that deals with a part of the steel industry called coke production. The basic idea in the 1990 amendments was that we were going to force innovative technology on this industry so they would clean up all of their pollution. In fact, what my testimony indicates is that in a number of cases what steelmakers have done is simply shut down their cokemaking operations and are now importing coke from Eastern Europe, and from China. I think any careful environmental analysis of what is going on in that industry would indicate that we are having less economic productivity in this country and we are having more air pollution in other countries.

Senator VOINOVICH. I will just finish up with this. We have heard criticism of risk assessment and cost-benefit. They say it will slow down the rulemaking process. I recall in testimony before the Governmental Affairs Committee, and you testified regarding Senators Levin and Thompson's Regulatory Improvement Act, we heard testimony that risk assessment and cost benefit analysis may actually speed up the process on implementing sound scientific regulations because it allows everyone to know up front what information was used during the decisionmaking process. I would like you to comment on that.

Mr. GRAHAM. Yes. I think a good example of this is the primary ambient air quality standards, where the law says you shall not consider the cost of these standards. But everybody in this town knows that you have got lobbyists running all around talking about costs all the time, you have got administrators who are making public statements about cost, yet supposedly we are not considering costs at all.

I think a far better idea would be to allow costs to be talked about explicitly and let the claims about costs be scrutinized. In many cases, those claims will be scrutinized and shown to be exaggerated, which will result in more consensus about in fact what the policy should be. So by driving the whole cost-benefit discussion underground and by making it secret, we don't make the process any more trustworthy, and we don't make the process any quicker.

Senator INHOFE. Yes, I think that is significant. I was just discussing it with Andrew here, that back during the ambient air debate, EPA was saying the cost of the change in those standards would be approximately $6 billion, then the President's Economic Advisory Council came out with about $60 billion, and then of

course the group that was out in California came up with $120 billion. I think your idea of scrutinizing these variances is very good and very significant because they are going to talk about costs and they are going to talk about it in a very emotional way that is not being scrutinized and evaluated. When you have a variance from $6 billion to $120 billion a year, you need to talk about it.

Mr. GRAHAM. Right. And you need scientific peer review of the economic projections, the technological and engineering projections that underlie those types of cost estimates.

We heard this morning from the gentleman from the Environmental Protection Agency that they don't consider costs when they do primary ambient air quality standards, yet the White House was, the Council of Economic Advisors was, the Treasury Department was. EPA was probably the only place in town that was saying publicly we don't consider costs, yet even they issued a cost-benefit analysis of that regulation.

So one has to have a certain cynicism about this process where we say we are setting this number just to protect the public health without regard to cost and everybody is doing cost analyses. I think we ought to bring it out in the open, make it more rigorous, and build it systematically into the process.

I think one of the points that was made by Senator Lieberman and Senator Baucus, which I think is a good one, is the nature of the cost-benefit test at the stage of an air quality standard should be different than the nature of a cost-benefit test at the final source or emissions standard. I think you have to be much more lenient and flexible in the cost-benefit test because you are asking the Agency to forecast costs to the entire industrial economy. When you have a specific source standard or emission standard, I think you can be more strict in the kind of cost-benefit test you insist upon.

Senator VOINOVICH. Mr. Chairman, may I?

Senator INHOFE. Yes. Take all the time that you want.

Senator VOINOVICH. I was thinking, and you I recall testifying when I was with the National Governors Association, we had a hearing on the question of where do you invest your dollars. So often the public's perception of what an environmental problem is is not connected with the real problem. In other words, because an issue comes up and people get excited about it and the Agency starts to deal with it, if you sit back and you look at what are the real problems, something else may be even a much more severe threat to public health than, say, some other problem.

I wonder if there were some way, and I would be interested in your reaction, as part of the amendments to the Act, to get the Agency, and maybe they have done this, but to sit down and really do an analysis of what are the real severe problems that are confronting the country and what have the largest impact on public health and direct their attention to those, rather than to go off maybe in some other direction where they get people to spend a lot of money and where we could be utilizing the dollars that are available in a much more effective way. There is X number of dollars available at the local level, political subdivisions, State government, business. The issue is how do you get them to use the dollars that are available, in terms of environmental, in the most cost-ef-

fective way to get a real return on your investment. Is there some way that could be done?

Mr. GRAHAM. Senator Voinovich, I think that there is, in fact, a strong usefulness of cost-effectiveness methodology to identify where we can save the most lives, do the most for public health for a given amount of expenditure. You heard already good testimony from Ms. Kerester about indoor air pollution. I think any fair analysis is going to show that additional investments are likely to give big gains in indoor air pollution control compared to outdoor air pollution control. I think they will also show that investments in outdoor particulate control are going to give you more benefits than investments in more air toxics control. The problem is the Clean Air Act was broken up into these pieces and nobody has responsibility for identifying where we can save the most lives with our clean air dollars.

Senator VOINOVICH. That might be a good idea.

Senator INHOFE. Well, I only have one last thing. We are taking a little longer here because we are down to two Senators. Maybe that will encourage better attendance.

I heard Mr. Perciasepe say right before I had to excuse myself and testify at the Senate Armed Services Committee that when the D.C. Circuit Court made their decision they did not consider science. Yet, in their remanding statement, they did refer to the negative UV effects on people. Now, isn't that science? Do you have any comments about that particular decision?

Mr. REVESZ. Let me address that, Senator.

Senator INHOFE. Yes.

Mr. REVESZ. There were references to scientific issues in the decision, but the rationale for sending the standards back to the Agency was that the court felt that the statute had not appropriately constrained the discretion of the Agency in setting the standards, and that the Agency itself had not appropriately constrained its own discretion and had not appropriately explained why it had gone down to where it had gone down and not had gone down further, because, after all, going down further, as Professor Graham explained, would have saved more lives, done more good. As I read that case, I think that was the primary rationale of the D.C. Circuit and they sent the regulation back to the Agency for the Agency to try to articulate some standards that were going to guide it in the future I guess in promulgating National Ambient Air Quality Standards for these pollutants.

So it was not primarily a scientific decision. It was an invocation of the nondelegation doctrine that primarily made these standards go back to EPA.

Mr. GRAHAM. Mr. Chairman, my understanding was they ruled as a unanimous part of that court's opinion that dealt with the smog and the ozone standards, and they did indicate that the Agency had not in any way considered the scientific evidence that ultraviolet radiation can cause skin cancer, cataracts, and that should be balanced against the ozone control benefits in the standard. That's the kind of hippocratic oath provision that the court is trying to bring into the law that I think Congress should just cut short and put it right into the statute itself.

Senator INHOFE. I see. That is a very good point.

Do you have anything else, Senator Voinovich?

Senator VOINOVICH. No, I haven't.

Senator INHOFE. Thank you very much. And by the way, all of the members are represented by staff here. You will be receiving questions for the record. So there are more people here than you are looking at right now. We appreciate it very much.

Senator INHOFE. I would hope, while the next panel is coming up, if we can get science introduced into this at an earlier stage, that we will have less emotional approaches. I can remember, Senator Voinovich, the very first hearing we had on the proposed changes in the ambient air standards on ozone and PM. They brought in all these kids with white masks from some hospital. It makes great for TV and all that, but it really does not help in getting to the truth and what we are trying to accomplish here. In fact, I can remember asking those kids how many of them use CFCs in their inhalers, and they all said they did, and I asked if they were aware that it was my understanding that the EPA and the FDA were working on programs to ban CFCs from their inhalers. So that kind of changed their attitude toward this thing.

We now have the third panel, which includes Mr. Michel Benoit, executive director of the Cement Kiln Recycling Coalition; Mr. Bernard Melewski, counsel of the Adirondack Council; and Mr. Bill Tyndall, who has been here before, vice president of the environmental services, Cinergy Corporation, on behalf of Edison Electric Institute.

It is nice to have you back again, Bill. Why don't we just go ahead and start with you since you are the experienced one at this table.

Mr. TYNDALL. I believe Mr. Melewski was there the same day, so we are sort of tied.

Senator INHOFE. Oh. Well, let's start with Mr. Melewski then. You're on.

[Laughter.]

Mr. MELEWSKI. All right. That was neatly done.

STATEMENT OF BERNARD C. MELEWSKI, COUNSEL AND LEGISLATIVE DIRECTOR, ADIRONDACK COUNCIL, ALBANY, NY

Mr. MELEWSKI. With respect to the long involvement of the Adirondack Council, a not-for-profit organization formed 25 years ago to protect the Adirondack Park in New York—the largest park of any kind in the lower 48 States, a six million acre park of public and private land—our involvement in the protection of the park and acid rain is very well documented in our written testimony. I want to go directly to a couple of main points.

One of the features that we have found useful, informative, and wise on the part of Congress in the 1990 Clean Air Act Amendments was the requirement that EPA, and then NAPAP, the National Acid Precipitation Assessment Program, which is comprised of multiple agencies in the administration, should report to Congress progress of the Clean Air Act Amendments, particularly the sulfur cap and trade program. Congress can make an assessment of the success or problems of that program. There have been two reports: one by EPA in 1995, and just recently a report was made

available by NAPAP. I would like to address the two major conclusions which we think are fair to make from those two reports.

First of all, the market-based mechanism—the cap and trade mechanism—is an overwhelming success. The Adirondack Council has been hawking this process. In fact, we took the Agency to court and I am happy to report that was resolved only just 2 weeks ago. We agree that the mechanism is an overwhelming success. It is extremely cost-effective. There is 100 percent participation, which is outstanding and almost a minor miracle. And it is accomplishing its primary task, which is to reach a particular cap in tonnage of SO_2, probably in advance of the schedule set by Congress.

Unfortunately, the second finding of these two reports is that the primary goal of the 1990 Clean Air Act Amendments, Title IV, which was to solve the acid rain problem and protect sensitive resource areas, is not being accomplished. In New York, it is particularly hard to accept that these report find that without additional reductions, we will lose over half the lakes of the Adirondack Park. And we have seen extensive damage in the Adirondacks, not just limited to the impacts of acid rain directly to the forests and the fish and wildlife of the park, but also it is extensively documented now that there is a public health impact. The document that I have included in our testimony discusses these issues.

For example, in the last year and a half, the Public Health Department of New York has issued fish consumption warnings for 15 lakes in the Adirondack Park and for three of the high elevation reservoirs for the New York City water supply because of mercury contamination via bioaccumulation in the fish. And the source is acid rain, both directly and indirectly.

The other major conclusion of these reports is that the problem is not just isolated to the Adirondack Park. It is an extensive problem that reaches from Maine to Georgia. In fact, all high elevation areas throughout the country, including Colorado and California, are now seeing the impacts of nitrogen saturation and soil acidification. Also our coastal estuaries, from Narragansett Bay to Long Island Sound to Chesapeake Bay and Tampa Bay, are seeing impacts from nitrogen loading.

So the problem is not limited just to New York; the problem is most severe in New York and we are in danger of losing the resources of our park. We were very pleased to have our organization, which is a small regional organization, joined by many organizations in an open letter to the public just recently, which I have up there, called "Your Best Chance to Stop Acid Rain Once and Forever," alarmed by the findings of the NAPAP report, and joining in the consensus that something more has to be done. The impacts of acid rain are felt here in the Capital as well. What is perhaps forgotten about acid rain, it has a severe impact on our monuments throughout the Capital and, in fact, our Civil War cemeteries in Gettysburg and Vicksburg. It is, unfortunately, very well documented by a publication of the U.S. Department of the Interior called "Acid Rain on our Nation's Capital: A Guide to Effects on Buildings and Monuments." It is actually a walking tour, that I urge you to take, demonstrating the damage to monuments such as the Lincoln Memorial, the Jefferson Memorial, and the Capitol Building itself.

We make two recommendations, quite briefly, and that is that we go back to the 1990 Amendments and Title IV and we make further reductions in sulfur, along the lines recommended in the reports; and that you also consider a national cap and trade program for nitrogen, because the reports also indicate that nitrogen is a big factor in acid rain. We know in New York that as the snow pack builds in winter, and nitrogen and the acidity of the snow pack builds, and an acid shock occurs to lakes and streams with the melt in the spring.

In conclusion, I would like to advise you that just in a matter of hours the Republican Governor of New York, George Pataki, will announce that he is directing his commissioner to develop regulations along the lines recommended by these two reports to make cuts in both sulfur and nitrogen to address acid rain in the next several years. Thank you.

Senator INHOFE. Thank you. I am glad you clarified that. I thought you were going to say he was going to announce for president.

[Laughter.]

Senator INHOFE. Mr. Tyndall.

STATEMENT OF WILLIAM F. TYNDALL, VICE PRESIDENT OF ENVIRONMENTAL SERVICES, CINERGY CORPORATION, CINCINNATI, OHIO, ON BEHALF OF EDISON ELECTRIC INSTITUTE

Mr. TYNDALL. Thank you, Mr. Chairman. My name is Bill Tyndall. Since August 1998, I have served as the vice president of environmental services for Cinergy Corporation, an electric utility based in Cincinnati, Ohio that provides 1.4 million electricity customers and 470,000 gas customers with service in Ohio, Indiana, and Kentucky.

Prior to joining Cinergy, I served Congressman Dingell as a minority counsel to the House Commerce Committee where I worked on Clean Air Act issues. I also worked on the Safe Drinking Water bill and represented Mr. Dingell and the Commerce Committee Democrats on that bill from subcommittee markup to signing by the President. I am very familiar with the standards-setting provisions and think there is a lot of overlap between the two bills and the cost-benefit provisions that were unanimously agreed to in that bill.

Still earlier, I was at EPA where I served as a policy advisor in the office of Air and Radiation. And I also was in the General Counsel's office, where, I should add, I was in the early 1990's peacefully minding my own business when I received a phone call regarding a situation in Lorain, Ohio and an expansion by Colby Steel of a facility there, and I actually came in and helped negotiate a settlement of that issue that I think resolved both EPA's concerns and allowed the project to go forward and lifted the stop work order.

But, in short, I am speaking to you as someone who has spent nearly 10 years addressing air policy issues from a variety of perspectives. I am today, as was said, appearing on behalf of Edison Electric Institute.

I would like to start by echoing what other witnesses have said. The Clean Air Act is working. We are seeing reductions. There have been dramatic reductions across the board from industrial categories. From the utility industry we have seen reductions in all the major pollutants. With full implementation of the acid rain program, for instance, which we are just in Phase I of, Phase II will start and will drive reductions in the next 10 years, we will see a total 7.5 million tons being removed from the air. We have had a particulate emission decline of 1.8 million tons, almost an order of magnitude since 1970. And has also been pointed out by other witnesses, these reductions have occurred in the electric utility industry against a background of growth that has matched the line that EPA put up on the board of the GNP.

Utility growth in terms of sales has increased between 1970 and 1996 120 percent, or some 13 billion kilowatt hours. So against a background of steady increase over 30 years, there has been steady declining of emissions. Of course, these emission reductions have had a price. Based on data filed by utilities, over $32 billion has been spent on controls alone.

As we look to the challenges of the next 10 years, to talk a little bit about what the committee is interested in in looking at the Clean Air Act and the structure of the Clean Air Act, it is obvious to anyone such as myself who must plan for additional compliance that powerplants are facing a myriad of uncoordinated, overlapping, and inconsistent regulatory requirements. In large part, the structure of the Act itself is responsible for this. The multiple programs under the Act all are driven by separate statutory requirements which, in fact, are aimed at the same pollutants from the same sources.

I have put up here for the committee two charts that show for NOx controls and then for SO_2 controls all the various programs that are coming at us along with a guesstimate of when they might hit. Of course, as you sit there and try to do planning, I have to both guess as to when it is going to hit and what the level of reductions will be. There also are a lot of different questions about the stringency or the flexibility of the program. To give one example that Mr. Melewski's testimony brings up, if you look at NOx controls from the point of view of the NOx SIPP call, it asked us to do seasonal NOx reductions. Seasonal NOx reductions means during the ozone season, during the summer we are going to make reductions in NOx. That is a hundred day period. The technology that may be most cost-effective, depending on your plant, may be SNCR, which is an injection into your boiler which doesn't require high capital costs up front but has very high overhead and maintenance costs. But if you turn around and tell me 3 years later that I am going to have to do year round controls, then I have just made the wrong decision because for year round controls the SCR technology, where we essentially hang a filter 20 stories up on a plant and filter the emissions coming out of the boiler, is the better technology because while the initial capital costs are higher, the O&M is lower. So if I have to run it year round, that becomes a better technology.

EPA, of course, is putting us on this mad rush for 2003 to meet the 0.15 for the seasonal reductions and is setting up a compliance

requirement that is basically going to then put us in a position where, if we are asked to make year round reductions, we have made some wrong decisions about compliance. So then we will either have wasted money and have go back and make changes, or there will be a lot of companies that will say wait a second, forget it, we already invested, we put on these controls and we are not doing anything more. And the issues that he legitimately brings forward will face that kind of opposition that it didn't need to if you can line up the requirements.

So I would close with the following observation. I think the utility industry is unique in facing this level of regulatory complexity because of the various programs. In that sense, it may be, and it is certainly Cinergy's view, that there may need to be a comprehensive approach for utilities that establish us with long lead times, with flexibility, with phase-ins, with early reduction credits, the kinds of things we know reduce costs, but sets up requirements so that we can do planning and understand what we are going to be required to meet. And with that, I think you can have a situation where both of us can come in and testify in favor of the same provision. And with that, I will conclude.

Senator INHOFE. Thank you.

Mr. Benoit?

STATEMENT OF MICHEL R. BENOIT, EXECUTIVE DIRECTOR, CEMENT KILN RECYCLING COALITION

Mr. BENOIT. Thank you, Mr. Chairman, Senator Voinovich. Good morning. Thank you for inviting me to testify today. I am the executive director of the Cement Kiln Recycling Coalition. CKRC represents cement producers that recover energy from hazardous waste and their kilns. In the United States there are 118 cement plants located in 37 States; 17 of those recover energy from over one million tons per year of regulated hazardous waste which they use as a one-for-one substitute for coal. That's enough energy to provide the power needs of the city of Tulsa for about 8 months. And if I could suggest only one change to the Clean Air Act, it is that we believe it should accommodate and encourage energy recovery technologies that reduce pollution.

I would like to offer a little bit of background first. This is a diagram of a cement kiln. Perhaps you have seen them. Cement kilns are very, very large industrial furnaces. They produce portland cement. They can be up to or over five hundred feet long, they can be over 20 feet in diameter. In other words, big enough to drive a tractor trailer through them. They are very hot. This is a picture of the inside of a cement kiln, an operating kiln. They operate at temperatures over 3,000 degrees fahrenheit, and they are among the largest industrial users of energy. What you see in that picture at the top is a coal burner, you see a burner feeding hazardous waste fuel, you see the product discharging at the bottom left.

Since the late 1970's, cement kilns have safely used hazardous waste as fuel. These are wastes like paint solvents, cleaning solvents, adhesives, printing inks; the kinds of materials that need to be managed properly, the kind of materials, frankly, that we do not want to see wind up in our environment. The critical point to keep in mind here is that EPA regulations mandate that these types of

waste cannot be land disposed. They must be burned in either industrial furnaces, boilers, or incinerators, and there is no alternative treatment for these types of energy-bearing wastes. Recovering energy in cement kilns yields many environmental benefits—fossil fuel energy resources are conserved, air pollution is significantly decreased, greenhouse gas emissions are reduced, and the waste materials are put to a productive use.

EPA has very recently promulgated the Hazardous Waste Combustors MACT rule under the Clean Air Act. Since 1994, CKRC has been working very closely with EPA on the development of this rule. And as you know, section 112 of the Clean Air Act instructs EPA to evaluate the emissions control performance of industrial sources of hazardous air pollutants. Section 112 requires EPA to assess the various control technologies and set emissions standards at a level of performance of the best 12 percent. This is known as the MACT floor level.

Unfortunately, the final Hazardous Waste Combustor MACT rule reflects a misuse of the Clean Air Act regulatory process, and we do not believe it is consistent with the intent of Congress. I have examples that I think bear this out in three areas; in the area of economic impact, risk reduction, and the use of science and technology.

In the area of economic impact, the Clean Air Act authorizes EPA to set MACT standards that are more stringent than the floor level that I mentioned. Section 112 instructs the administrator, however, to consider cost and other factors before setting such standards. In EPA's past MACT rules, the Agency has generally found acceptable cost-effectiveness levels for its decisions in the range of about $5,000 to $14,000 per ton of pollutant removed, an average of about $8,500 per ton of pollutant removed. In the Hazardous Waste Combustor MACT rule, EPA accepted a cost-effectiveness level of $500,000 per ton of pollutant removed, 60 times higher than the average in all previous MACT rules.

Now, you would expect that at that at high cost levels there would be some environmental or public health benefit gained. However, in letters to Senators Graham and Hutchison responding to some oversight inquiries, EPA addressed the risk reduction in the Hazardous Waste Combustor rule and said, "We do not project a reduction in numbers of children with blood levels that exceed the Centers for Disease Control intervention level." Specifically, in the final rule, EPA says that the benefit to children's health is a decrease in an incidence of elevated blood lead levels of 0.4, four-tenths of a case per year out of the entire U.S. population of over 250 million people, and we are not sure really how they measured that.

Third, in the area of science and technology, as you know, Congress intended the Clean Air Act in section 112 to be technology-forcing. However, in setting the standards for metal emissions in the Hazardous Waste Combustor rule, EPA said that reducing the amount of waste burned in hazardous waste combustors is a control technology. So even though EPA has said in other regulations that these wastes have to be burned, there are no alternative technologies, EPA concluded in the rulemaking that the way to control

emissions from these wastes is not to burn them at all, or not to burn them in the first place.

The practical effect of this is to force cement kilns to burn less waste, to reduce their level of energy recovery, and to burn more coal. We don't think that makes sense. In fact, if this type of logic is fully extended to a manufacturing process, such as an oil refinery, for example, it means that the best performing oil refinery will be the one that feeds no crude oil to the process.

Now there are several ways to fix these problems. One, of course, is through litigation. CKRC will be filing a petition for review on this rule in the D.C. Circuit. Another way, which we are here to talk about today, is for Congress to reauthorize and amend the Clean Air Act. Our recent experience with the MACT program indicates that Congress should be concerned about three important points. First, Congress should specify the findings necessary to go beyond the MACT floor in setting emission standards. Second, Congress should make clear that reducing feed to a process is not a control technology. Finally, Congress should ensure that the Clean Air Act accommodates and encourages energy recovery technologies that reduce air pollution. Thank you, and I look forward to answering any questions you may have.

Senator INHOFE. Thank you, Mr. Benoit. The last of your statement answered the major question I had to ask you.

Senator Voinovich?

Senator VOINOVICH. I was interested in Mr. Melewski's comments. I would be very interested to have the utilities that are represented here respond to what you think is a solution to the problem. I just want to make two comments about it. One is, I am glad you promoted the allowances and credits early on because they were used. But you are probably not aware of the fact that the Government did everything in their power not to allow us to use the allowances. When they initiated the process, they went to a cue and it was going to be triggered by telephone calls to I guess one of the departments, the Department of Energy, EPA.

When I came in as Governor, Mr. Chairman, we got all the utilities together in the United States that were interested in going after the credits and allowances and got them all in a room, it took a lot of work, and got them all to agree that they would share the credits and that it wasn't going to be a first come, first serve situation. Because the way it was set up was that the first ones would have gotten the credits and the rest of them wouldn't have gotten anything. So there was a real attempt at that time, I will never forget it, to really preclude us from sharing these allowances and allowing utilities more time to do some of the things that were necessary for them to continue to burn, in some cases, high sulfur coal or make other alternatives.

Second, I followed the acid rain provisions from the beginning and was down here as a mayor. One of the things that always puzzled me was President Reagan undertook a big study, that everybody applauded in the beginning, and, as you may recall, the result was they said that the acid rain coming from the utilities perhaps wasn't as serious a problem as what people made it out to be, but, in the end, those recommendations were ignored and they went ahead with those provisions. There were very few Senators that

voted against that legislation. Senator Glenn from Ohio was one of those that did because he was concerned about that.

The question I am asking you is, are you really sure that the problems that you are experiencing in terms of the lakes and the soil and the fish are caused by the emissions from these utilities?

Mr. MELEWSKI. We are absolutely certain. The report that you were referring to in the 1980's was the start of this scientific inquiry that has now culminated in not only the reports back to Congress, which I said were wise to require, but also numerous other studies, including some that have just come out last week that continue to verify this correlation between the transport of pollution and the subsequent problems.

Keep in mind also, and I too hope the utilities will react, and very favorably. What we are recommending is not changing the mechanism, which is working very, very well, especially to keep costs down. It provides any particular utility the flexibility to come into compliance in the most cost-effective manner, and over a long time span that is conducive to business planning. The reports do clarify very well that there is a direct correlation between the reductions and the deposition in sulfur.

So we know we are doing the right thing to get at the right pollutant. The results, the monitoring on the ground which have been going on in the Adirondacks since the 1970's on a continuous, daily basis of at least 52 lakes in the park, document these changes quite well, as well as other studies throughout the Northeast. So I think we are on absolutely the right track. If you will, what we are proposing is not to change policy, but to reaffirm the policy and commitment that the Nation made in 1990, which was to adopt a market-based program that would solve the problem.

Senator VOINOVICH. I am going to be anxious to read that report. I will be interested to see what the reaction is to it.

One last comment, and that is, Mr. Tyndall, you are involved in the issue I talked to Mr. Perciasepe about, and that was the NOx standards, the call that they have put out in terms of reducing 85 percent of your emissions. Do you want to comment on that in terms of your moving forward with trying to be a responsible corporate citizen and cleaning up the air, and dealing with some of the problems they have particularly in Pennsylvania and a little bit in the other Eastern States?

Mr. TYNDALL. There are several things to say about it. One is I would second what you observed earlier, that there was a real attempt to put something substantial on the table by Midwest and Southern States that was well within the range of reductions that the OTAG, the technical group, said was necessary. That was essentially rejected, nor were there even any attempts to try and see if there could be an accommodation between the views of the Northeast and the views of the Midwest and the South. We still continue with the war going on between the two regions, which I don't think is productive for anybody and I don't think it is productive for cleaning the air.

Of course, that leaves us trying to guess at what our responsibilities are going to be. The State of Ohio, first under your leadership and under your successor's leadership, is moving ahead on putting the kinds of reductions on the table that they said they would. I

think the modelling that the State of Ohio has, the modelling the State of Indiana has shows that level of reductions, the level represented by a 0.25 reduction, should resolve issues. But there is also continued working and trying to find a compromise that is acceptable, and the State of Ohio has been very active on that.

The other part of it, however, is that we have NOx that is in front of us right now, but there are any number of issues, including the issue being raised today, where what we do on NOx could be totally inconsistent with what another part of EPA is pushing us to do. Yet, under the statute, under the way the Act is being implemented, there is no attempt to try and coordinate these or look at these. So we are going to make investment decisions and, if we make investment decisions that make it difficult for us to move to annual emissions, we will certainly bring that out.

We have tried to talk to the Agency about this, we have said to the Agency why don't you try and coordinate all these things. And while they won't directly say this because it is their view they don't want to reopen the Clean Air Act, the truth of the matter is they can't. There are independent statutory provisions that drive forward requirements that give us that long list and that have reduction programs or reduction targets under consideration that are inconsistent, that have more or less flexibility, that are unit by unit, that are system, all sorts of different mixes and matches that makes it difficult for Cinergy to set a course and say over the next 10 years here is what we will do for NOx, here is what we will do for SO_2, here is—there are other issues on the table. It makes time to draw that roadmap impossible.

And so I do think there is a better way of doing it. I do think, however, that it is going to lay the problem in the committee's collective lap, that it is not going to be done by the Agency or the Administration.

Senator VOINOVICH. I would just like to comment that we are talking about responsible amendments to the Clean Air Act. The Chairman is going to be having hearings. We certainly would welcome recommendations from the environmental and from the business community and from State and local governments about how we can do a better job of utilizing our resources.

I think what you are suggesting is that the left hand ought to know what the right hand is doing; that there ought to be some place where people come together and say these are the goals that we would like to set dealing with the Adirondacks, with this goal, with that goal, how do you put a plan together that you will commit to over a long period of time that says to you that if you make these investments, that next year someone won't come back and say I'm sorry, it is not enough and you have to go beyond, or I'm sorry, what you are doing is causing other problems and you are going to have to deal with that problem. It just is not the way to get things done. I don't think it helps the environment and I don't think it really helps our competitiveness in terms of our businesses in this country.

Mr. Chairman, that is one of the other sides of this thing that nobody is concerned about, and that is that we are in an international marketplace. Our environmental policies not only have to do with the environment, but they also have to do with our com-

petitive position in that global marketplace. We need to be darn careful about the investments to make sure that we are getting a return on those investments in terms of our air and water.

Mr. MELEWSKI. If I could, I would comment on Mr. Tyndall's point about the need for Congress to take a look at these programs, just from a slightly different perspective. He was concerned about the conflict between perhaps summer ozone controls and year round controls. The announcement that Governor Pataki is making today that New York is going to unilaterally do these severe reductions in SO_2 and in NOx year round in New York gives New York clean hands, so to speak, and will provide us some health benefits, but it is really just giving us some extra time in the Adirondacks and perhaps the Catskills before we lose those parks. New York cannot unilaterally solve its problem, and it certainly cannot unilaterally get consensus to do year round controls. The change in the SO_2 program and the possibility of year round controls in NOx will have to come back here.

Senator VOINOVICH. Well, I want to say that I congratulate Governor Pataki, and I say finally, because Governor Pataki and I have had differences of opinion on this issue for a long time. I have said to him "You're asking us to solve your problem. What are you doing in your State to be a good citizen." And I think this is a positive step on his part. And you're right, I think it puts him in a much better position in terms of when he is at the table with some of us who have said it's your problem and not ours, and have said you're not doing anything in your own State. I will be anxious to read about what he is doing and how it is going to be worked out. Thank you.

Senator INHOFE. Thank you, Senator Voinovich.

I think almost everything I was going to ask has been discussed. I would think though, Mr. Tyndall, and I don't mean to make this sound unkind or unfair to the Administration, but I have often said that one of the things a lot of them have in common is they have never had a job in the real world and, consequently, have an insensitivity to the impositions that are imposed on people. I say that because I am somewhat prejudiced since I spent 35 years on your side of the table instead of on this side.

When you have these changes that take place and you are expected to reach certain levels and then next year they change and they change the rules, there is a tremendous cost in corporate planning to prepare for these things. We have talked around this, but it would be interesting to try to quantify these costs. Let us say we made a decision today that would take care of the next 5 years as opposed to doing it today and then coming back next year, it would be a very difficult thing to do but it would be helpful to us to know, as Senator Voinovich brought out, there is a global component to this, what the cost is compared to doing the same thing in another country.

Mr. TYNDALL. I think it is possible to get some idea of the cost-savings involved both in coordinating and in making sure that things are done with adequate lead times and with flexibility. I know internally that we looked at the NOx SIP call, the 0.15 pound per million BTU, and our own economic forecasters, the same people we use to predict the price of electricity, so the people we rely

on for financial decisions looked at this and they basically noted that you take the same requirement, instead of having this mad rush to comply over, from our point of view, essentially seven seasons of when we can have outages to install the controls, instead of having this mad rush to comply, if you allowed a phase-in, if you allowed the accumulation of early reduction credits, the same sorts of things that are used in the SO_2 program, you could end up at the same point for half the amount of expenditures.

When I joined Cinergy they brought me the budget for trying to comply with the 0.15 and it was, and this is a number we have made public so I can say it, it was over $700 million, which was, by the way, twice what EPA estimated our compliance would cost. And I did say, because I know from being outside that industry tends to exaggerate these costs, right, so what is the real number. But, no, this is what the engineers and the consultants and everyone who is putting this together said. There's the construction crews, the cranes, the sheet metal workers, and all the stuff that goes into putting in place the huge number of controls required under EPA SIPP call. We were doing projects at every single plant. When we looked at that, we ended up at a number double what EPA said we were going to do.

And I, of course, am friends with the person who does a lot of the EPA modelling, and I called him up and said "Our numbers are double, we have the double the SCR you are predicting." And he said, "Well, you are clearly wrong." And I said, "Well, this is our business. We are writing contracts." Their refusal to say—we have programmed that those are the numbers, sorry. In fact, for the NOx SIPP call it is a very different price than the SO_2 system because they did not build in the flexibilities that they built into the SO_2 compliance.

Senator INHOFE. I think you have answered that question.

Mr. Melewski, I think during the debate in 1990, you originally did not support the acid rain trading system and now you do; is that accurate?

Mr. MELEWSKI. I think we were very skeptical about the trading system at that time. We certainly preferred an overall mandatory reduction. And some of our concerns have been borne out. We were very concerned about target level. Those have been borne out, that's why we are here today. But we were also concerned about the compliance record and whether trading would allow concentration of allowances in certain regions and how that would play out. And we have looked at alternatives to that system, at the time a regional trading system, regional controls. But it is quite clear now that the system is working very effectively. The kinks have been ironed out over the last few years.

Senator INHOFE. In your opening statement, I think at the very last you even suggested expanding that the pollutant of NOx. There are problems here. Around the country, the cost of a ton of NOx reduction varies so widely from one part to another part, same as the benefits. That would be very difficult to address, but I am sure you have thought that through. Do you have any comments about that?

Mr. MELEWSKI. I think that the mechanism that is in place for the SO_2 allowances provides that kind of flexibility. You can buy

allowances, you can install controls, you can tailor make your own strategy to come into compliance. The reason we are advocating for a national cap and trade program for nitrogen is also the economic benefits. The areas outside those 22 States are going to see benefits from the reductions in nitrogen, and in a bigger market costs will go down.

Senator INHOFE. Any reaction to that or comments?

Mr. TYNDALL. We do agree that if you have a broader market and more participants, and if you have a control level that allows over control, which, again, is a problem with the NOx level, that you then will have an active market and it will allow the market to even out control costs. But you have to have a system that allows the development of that market, you have to have a control level that allows the generation of allowances, and all of those things, and not to pick on the NOx SIPP call, but all of those things were reasons why we had serious concerns about whether the NOx allowance market would have functioned the way EPA wanted it to function. It doesn't mean that one can't be designed that would provide the same equalization of compliance costs as occurs with SO_2.

Senator INHOFE. All right. First of all, let me thank all of you, and not just this panel but previous panels, for being in attendance today. This is very significant to have this as the first hearing. We appreciate your time very much.

Is there any last comment that you are just dying to say that you didn't get an opportunity to say, Mr. Benoit, Mr. Tyndall, or Mr. Melewski?

Mr. MELEWSKI. Well, I will take a shot at that. I think that Governor Pataki's actions today reflect the knowledge of the mercury contamination in New York, the stories of lead poisoning as a result of acid rain that are contained in our documents, that New Yorkers are extremely concerned about this issue. I think we all should be concerned about the prospective loss of one of our greatest parks. While I respect the need for due diligence and deliberate speed in Congress, I think that prompt attention to Title IV would be appropriate, and the sooner the better.

Senator INHOFE. All right.

Mr. Tyndall?

Mr. TYNDALL. I would just add one thing. Having worked for 4 years with someone who I think still swears that he will never stand for the Clean Air Act to be reauthorized, my former boss, Mr. Dingell, I think it may be that one thing the committee should consider is whether it makes sense to take some issues that everyone knows need to be addressed and address them in a more individual series of bills, such as you did with your amendment to the transportation bill, in which we accomplish something but with not trying to take on every issue in the Clean Air Act. I think trying to move individual bills as opposed to putting them all together in an omnibus Clean Air Act reauthorization, no one is going to have a personal life for a year, bill is maybe a better approach. I don't want to be a Monday morning quarterback, because you have excellent staff, but just some advice.

[Laughter.]

Senator INHOFE. All right.

Mr. Benoit?

Mr. BENOIT. If I could make one final point, Mr. Chairman. We heard a fair amount today about the importance of cost and benefits, risk reduction, the use of sound science. And I was struck by Mr. Perciasepe's remarks about the ability of U.S. industry to innovate in response to statutory, and regulatory objectives. I would like to point out that I think a fine example of industry innovating is the ability of existing industries to use waste materials, put them to work to reduce the use of fossil fuels, reduce the use of virgin materials, and in almost all instances doing that in a way that reduces emissions and reduces pollution. I truly hope that the Clean Air Act can be tailored to specifically accommodate and encourage that type of activity.

Senator INHOFE. Sometimes a compliment on the innovation and the abilities of industry to respond is another way of saying we are going to make the decisions, you figure out how to make them work.

[Laughter.]

Senator INHOFE. Thank you very much. I appreciate all of you being here.

The hearing is adjourned.

[Whereupon, at 11:37 a.m., the subcommittee was adjourned, to reconvene at the call of the Chair.]

[Additional statements submitted for the record follow:]

STATEMENT OF HON. CRAIG THOMAS, U.S. SENATOR FROM THE STATE OF WYOMING

Thank you, Mr. Chairman, for holding this hearing today to lay the groundwork for eventual reauthorization of the Clean Air Act. This issue is of great importance to the entire nation, but particularly to the West and my State of Wyoming where we have some of the nation's cleanest air and world class reserves of coal and natural gas, as well as wind resources. I am especially interested in the issue of cost/benefit analysis and look forward to the discussion in today's hearing. Far too often, environmental regulations adversely impact the economy while offering minimal environmental benefits. We must move carefully and thoughtfully as we think about reopening the Clean Air Act.

Since enactmentment of the 1990 Clean Air Act amendments, the Clinton Administration has tried various ways to implement even stricter standards. I, along with many others including State and local governments, and many of the nation's Governors—vocalized our opposition to the EPA's rule on Particulate Matter (PM) and Ozone. One of the most troubling aspects of the process is EPA's rush to implement standards without sound scientific data. In May, the U.S. Court of Appeals for the DC Circuit held that EPA had overstepped its authority in proposing the revision of the ozone standard. Yet despite this action, EPA continues to move forward with a new NOx regulation.

It is paramount that principles of sound science be applied. I remember clearly the debate we had several years ago over EPA's rule for Particulate Matter and Ozone. Here in this committee, Dr. George Wolff, the Chairman of EPAs's Clean Air Scientific Advisory Committee at that time, stated that the court ordered deadline did not allow enough time for its members to adequately examine that complex issue. Ultimately, there was no scientific consensus. And despite the ambiguity and lack of scientific data which was documented by the experts who testified, EPA went on to set new standards for PM and ozone—an action based on a judgment call rather than sound scientific evidence. We need to be careful about going down any regulatory road before we have good science to support any measure.

My point Mr. Chairman, is this: what we are seeing from this Administration is one extreme proposition after another. American businesses and industries have made great strides to improve air quality. America's air is much cleaner than it was 25 years ago. Nevertheless, the EPA continues to add layer upon layer of regulatory requirements on the backs of States and industry. It's critical that we keep the issues of cost benefit analysis and sound science in the forefront as we begin the discussions to reauthorize the Clean Air Act.

Thank you and I look forward to hearing from our distinguished panel of witnesses.

STATEMENT OF HON. DANIEL PATRICK MOYNIHAN, U.S. SENATOR FROM THE STATE OF NEW YORK

Good morning, Mr. Chairman. Thank you for holding this hearing on the reauthorization of the Clean Air Act. It is clear that the Clean Air Act and the 1990 amendments to the bill have resulted in a significant improvement in air quality, and a better understanding of the science of monitoring, measuring and controlling air pollution. The regulatory flexibility of a "cap and trade" program, exemplified by the S02 Allowance Program, has been successful because of the flexibility it allows affected utilities. It promotes innovation and competition in emissions reduction technologies and has produced tremendous cost savings. Since 1990, studies have estimated that the cost savings due to emissions trading, compared to the traditional command-and-control approach, have been between $230 million and $600 million per year. These successes are encouraging but our work is not yet done.

I testified before this committee last year about the pioneering scientists at Cornell University, Carl Schofield, Eugene Likens, and Charles Driscoll who were among the scientists responsible for establishing a strong link between acid deposition—primarily caused by upwind utilities—and the diminished ability of lakes to sustain healthy fish populations. We have made tremendous progress in understanding the causes and effects of acid deposition and ways to control it, but we still have a long way to go to mitigate these problems. We have learned, for instance, that the S02 emissions reductions required under the Clean Air Act Amendments of 1990 are insufficient to prevent the continued acidification of many lakes and further damage to sensitive ecosystems.

Perhaps most importantly, since the 1990 Amendments were enacted, we have learned that nitrogen oxides, which were largely ignored 8 years ago, play a significant roll in acid deposition. And we have learned that acid deposition does not cause environmental degradation just in remote, high-elevation forests and lakes in the Adirondacks and northern New England. Rather, it poses a continuing and significant threat to the environmental quality of lakes, streams, forests, bays, and estuaries throughout the country. The Southern Appalachians, the Front Range of Colorado, and the San Bernardino Mountains in California are greatly affected by acidification and nitrogen saturation. Eutrophication is adversely affecting coastal waters throughout the eastern seaboard, including the Chesapeake Bay, Long Island Sound, and the Gulf of Mexico.

Achieving cleaner air has a twofold solution: identify and control both mobile and stationary sources of pollution. The transportation sector accounts for nearly half of national NOx emissions. A large portion of these emissions are in the form of tailpipe exhaust from our national vehicle fleet. In recent years, advances in vehicle technology have produced Low Emission Vehicles (LEVs)—vehicles designed to reduce vehicle emissions by 90 percent. These vehicles were first sold in New York beginning with the 1998 model year. Unfortunately, New York can not see the full air quality benefits of these vehicles because New Yorkers do not have access to the low sulfur gasoline these vehicles have been designed to use. The problem is not limited to LEVs, although these vehicles are especially sensitive to gasoline sulfur. All vehicles in the national fleet with catalytic converters—virtually all vehicles—produce higher levels of emissions because of the high levels of sulfur in the gasoline they burn. Once the catalytic converter is damaged, it permanently loses its ability to filter pollutants.

In conclusion, I want to say that the success of the 1990 Clean Air Act Amendments cannot be questioned. The S02 Allowance Program established by that legislation has achieved extraordinary benefits at program compliance costs less than half of initial projections. The efficacy of the approach is proven. The current science indicates, however, that we did not go far enough in 1990 in setting our emissions reduction targets. We must buildupon our accomplishments thus far, and to begin the work which remains to be done. Thank you.

STATEMENT OF HON. BOB GRAHAM, U.S. SENATOR FROM THE STATE OF FLORIDA

Thank you Mr. Chairman, for the opportunity to speak at this important hearing. I want to thank all of the distinguished witnesses who are here to testify today.

The Clean Air Act has been a resounding success. A recent Congressional Research Service report notes that " the Clean Air Act and its 1990 amendments appear to have contributed to a marked improvement in air quality nationwide." Since

passage of the 1990 amendments, more than one-half of the areas not meeting air quality standards for ozone in 1990 now meet those standards. 33 of 42 areas not in attainment for carbon monoxide in 1990 now meet the standard.

At the present time, my State can boast attainment of all national ambient air quality standards. Unfortunately, this status will change with the new millennium. As we enter a new century and a new millennium, beautiful Tampa Bay and Pensacola, with its sugar-white sand beaches, will both be redesignated as non-attainment areas for ozone.

I asked the Florida Department of Environmental Quality the following question: What measures would provide the most improvement in air quality for Florida? The answer was 1) the Tier II automobile emissions standards, including the low sulfur standard, and 2) phasing out the so-called "grandfathered facilities." These facilities are the older fossil-fuel fired power plants that were not required to meet the New Source Performance Standards (NSPS) in the Clean Air Act.

I would like to briefly discuss both of these measures, and get feedback from today's witnesses, especially as they pertain to Florida. As we are all aware, sulfur in gasoline interferes with the performance of cars' emission control equipment. Some have advocated regional standards for sulfur, based on regional air quality. I disagree. Florida attracts 45 million tourists per year to our beautiful shores and attractions. Many of these vacationers bring their cars. As you drive down I–95 or I–75 in Florida, you can spot license plates from just about every State. These cars travel through and across many regions to reach our shores and attractions. Differing regional sulfur standards would significantly reduce the efficacy of the emissions control equipment.

In those regions of Florida that will be in non-attainment in 2000, specifically Pensacola and Tampa Bay, power plant emissions are the major contributing factor. When the Clean Air Act was crafted, older power plants were not required to meet the new source performance standards because it was thought that the remaining lifetime of the plants would be short. Requiring costly upgrades to plants that would not have time to amortize these capital expenses seemed unfair. As it turned out, most of these older plants continue to operate today, emitting far more than their fair share of pollutants. In a restructured electricity market, it has been estimated that allowing these older plants to continue to operate without complying to the new source performance standards amounts to approximately a 2 cents/kWh subsidy.

I am very interested in examining steps that could be taken to bring these older plants into compliance with the new source performance standards in a way that is fair to all involved. These steps would provide a significant benefit of the environment as well as a way to level the playing field in electricity competition. Thank you.

STATEMENT OF HON. BARBARA BOXER, U.S. SENATOR FROM THE STATE OF CALIFORNIA

Good morning, Mr. Chairman. Thank you for holding this hearing today to consider the progress we have made toward bringing Americans cleaner, healthier air under the Clean Air Act.

I believe that the considerable progress we have made toward achieving cleaner air is owed in large measure to one basic principle embodied in that law. That principle is that when it comes to setting the standards designed to protect the air our children breathe, we should consider only how to best protect public health.

What kind of progress have we made under the law since it was amended in 1990?

Since that time, we have reduced ground-level ozone, particulate matter and carbon monoxide pollution, we have reduced the levels of acid rain producing sulfur emissions, we have reduced the levels of stratospheric ozone depleting chemicals, and we have reduced the amount of toxics in our air.

In California, we have also made great progress on these fronts—reducing the levels of soot and smog that lead to health problems ranging from asthma to decreased lung function.

Between 1980 and 1997, for example, statewide ozone levels have decreased 49 percent. Statewide levels of particulate matter (PM10) have decreased 31 percent between 1987 and 1997. At the same time, California's population and motor vehicle miles traveled increased 16 and 26 percent, respectively.

It is well worth noting that the advances brought by the Clean Air Act have been achieved at much lower costs than predicted by critics of the law. For example, a study prepared by critics in 1989 predicted that the acid rain program would cost between $4.1 billion and $7.4 billion. Other industry estimates were much higher.

The General Accounting Office's most recent cost estimate for this program is approximately $2 billion; independent economists place the cost at only $1 billion.

Another industry study prepared in 1993 predicted that the law's reformulated gasoline program would add 16 cents to the price of each gallon of reformulated gas made. Actual costs of the program, however, are today estimated at between 3 to 5 cents per gallon.

While these and other doomsday cost predictions have not been borne out by experience, we have witnessed the law spur the development of new, innovative technologies.

Since the early 1970 amendments to the law, vehicle emission control technologies have been developed that reduce emissions from cars by 99 percent. Control technologies for stationary sources have also been revolutionized. For example, Selective Catalytic Reduction technology can reduce the emissions of nitrogen oxides from utilities, refineries, and manufacturing by up to 90 percent.

Would we have seen these technological advances without a tough law on the books? I don't think so.

But much more remains to be done.

California still suffers from some of the most serious air quality problems in the nation. Approximately 30 million Californian's live in counties that don't meet the law's health-based air standards.

Although air quality in the Los Angeles area has shown improvement for the first time this year, it still has among the worst air quality in the nation. We know that the smog and soot that plagues the L.A. area may have serious health consequences for the approximately 15 million people that live there.

A recent study, for example, found that air pollution in that region may impair children's long-term breathing capacity, leaving them vulnerable to respiratory disease and underdeveloped lungs. Asthma, which is exacerbated by air pollution, is also on the rise.

In 1997, EPA finalized rules that would have helped us reduce those health risks. Unfortunately, those new rules were thrown into doubt by a May 14, 1999 Federal appeals court ruling. In the case, the court resurrected a discredited 1950's legal doctrine to call those rules into question. Even very conservative legal scholars find the court's ruling puzzling.

So, while EPA and the Department of Justice appeal that ruling, the cleaner air that American's deserve is on hold.

The ruling, however, offers this committee guidance in what it did not find.

The court did not find that EPA relied upon bad science in establishing those new clean air rules. The court did not find that EPA acted beyond its authority in excluding a consideration of costs in setting those new standards.

The last thing we need to do in this committee is to buy into the argument that the science used by the EPA in its air program is flawed, or that costs should be considered in setting our air standards.

I look forward to hearing the testimony of the witnesses here today.

Thank you, Mr. Chairman.

OFFICE OF THE GOVERNOR, STATE OF NEW YORK,
October 27, 1999

Hon. JAMES INHOFE, *Chairman,*
Subcommittee on Clean Air, Wetlands, Private Property, and Nuclear Safety,
United States Senate,
Washington, DC 20510

DEAR CHAIRMAN INHOFE: Thank you for providing me with the opportunity to submit to you my testimony on New York State's important new acid rain reduction initiative. I believe this innovative proposal not only demonstrates my strong commitment to protecting the quality of New York's air resources, but also provides the U.S. Congress and other States with compelling documentation of the need for and application of stringent reductions in air pollutants with respect to costs and environmental and public health benefits.

The reductions that will be made to New York State's electric generation facilities will have real and perceivable benefits upon the areas of the State that are most sensitive to acid rain Moreover, the actions we have repeatedly requested, and will continue to request from other States, are no greater than the demands that we place upon our own facilities.

I urge you to give the enclosed comments careful consideration as you review the Clean Air Act and consider amendments to it. In particular, T urge your strong support for S. 172, Senator Moynihan's insightful legislation, which if enacted, would

greatly assist the environmental quality of New York State and many other areas of our Nation that are sensitive to acid rain. This bipartisan legislation has also been introduced in the House of Representatives by New York Representatives Boehlert and Sweeney.

Thank you for your consideration of our initiative. I look forward to discussions with you and your colleagues as you debate the future of the Clean Air Act.

Very truly yours,

GEORGE PATAKI,
Governor, New York.

STATEMENT OF HON. GEORGE E. PATAKI, GOVERNOR OF NEW YORK

Mr. Chairman, I want to thank you and the other members of the Senate Environment and Public Works Subcommittee on Clean Air, Wetlands, Private Property and Nuclear Safety, for providing me with this opportunity to share with you the details of an historic initiative by the State of New York, one which I believe will further demonstrate our commitment in the fight to protect and preserve New York's water bodies, natural resources, and citizens from the devastation of acid rain and smog.

New Yorkers care deeply about the quality of their environment. As the Governor of New York State, my Administration consistently has recognized and responded to this high priority of our citizens. I have repeatedly taken actions to preserve, protect and improve the quality of the State's environment and natural resource base for now and generations to come.

These actions have taken form, through full funding for the State's Environmental Protection Fund, and through the approval by the voters of New York State of the $1.75 billion Clean Water/Clean Air Bond Act of 1996. We are preserving the quality of drinking water for nine million New Yorkers, thanks to an historic 1997 agreement to protect New York City's Watershed. We have developed, and are implementing, management plans for critical water bodies throughout New York State, including Lake Champlain, Onondaga Lake, Long Island Sound and the Hudson River. And we have preserved over 250,000 acres of open space—the shoreline of Lake Erie; the Whitney and Champion properties in the Adirondack Park; Sterling Forest in Hudson Valley; the Albany Pine Bush; Mount Loretto in New York City; and the fragile Pine Barrens of Long Island.

Under my direction, we also are meeting State recycling goals, closing the Fresh Kills Landfill, and cleaning up brownfields which would otherwise remain as abandoned and unusable. But some of my greatest concerns continue to be over the need to improve air quality for all New Yorkers.

On October 14, 1999, I announced a significant new clean air initiative that will have important environmental and public health benefits, and that will reaffirm New York's leadership in the fight against air pollution. This announcement complements the many efforts which New York State has taken to demonstrate our national leadership in the fight for reductions in the emissions of air pollutants that cause acid rain and ozone (also known as smog) both inside and outside of our borders.

Let me briefly explain to you the history of the acid rain issue, as it impacts New York State, and why this recent Clean Air initiative is so important to us.

The State of New York created the Adirondack Park, and the people of the State invested it with special, "forever wild" constitutional protections, more than a century ago. Measuring about six million acres—about equal to the size of the State of Vermont—it is the largest park of its kind in the United States, covering one fifth of the land area of the State and containing the largest assemblage of Old Growth forest east of the Mississippi. It is a glorious, perpetual and pristine wilderness.

During the early 1980's, there were projections and evidence of widespread destruction of lakes in the Adirondack area as a result of acid precipitation. Although the New York State Department of Environmental Conservation (NYSDEC) had been gathering data since 1977 on lakes believed to be sensitive to acidification, a review of the chemistry and biology of these waters presented an incomplete picture of past and existing conditions. As a result, it was apparent that a more standardized, detailed and comprehensive survey was needed to determine the extent and magnitude of acidification of waters in New York State. In order to gather the information that would serve as a baseline for evaluating future environmental changes, and to provide a basis for decisions relating to reductions in pollutants, the Adirondack Lakes Survey Corporation (ALSC), a not-for-profit corporation, was formed.

From 1984 to 1987, field investigators focused on the collection of detailed chemical, physical and biological data from 1,469 Adirondack lakes and ponds. These data

showed that 352 water bodies had pH values of 5.0 or less, and fish were not captured in 346 of the waters surveyed. Fishless waters were characterized as having low pH, limited ability to neutralize acid, low calcium concentrations, and high aluminum values.

Since 1984, nearly $13 million in research projects have been completed or are ongoing under the auspices of the ALSC. The ALSC continues to be a cornerstone for cooperative scientific investigation with the U.S. Environmental Protection Agency (EPA), universities, NYSDEC, the Adirondack Park Agency, and other State and local organizations. Its careful studies have documented the continuing loss of Adirondack lakes to acid rain, and the need to address this problem at its source—the facilities where the emissions occur.

The many studies of the ALSC have demonstrated their worth. In 1990, when Congress approved the Clean Air Act Amendments (CAAA), the documentation that we provided to Senator Moynihan and others who were instrumental in the development of this legislation, provided the justification to statutorily protect the Adirondacks, the Hudson Highlands, Long Island Sound and other sensitive receptor areas—regions which are sensitive to acid rain—through Title IV of the 1990 Act.

Through this Congressional action, an innovative "cap and trade" program was created as a free market based approach to reduce the emissions of acid rain precursors. This program provided utilities with the flexibility to make compliance strategies part of their long-term business planning.

After court challenges and many debates, this program is now at work, making cost-effective air pollution controls a reality.

In crafting the CAAA of 1990, Congress also wisely called for studies to demonstrate the effectiveness of Title IV on protecting sensitive receptor areas. These recently published reports, EPA's Report to Congress, the Acid Deposition Standard Feasibility Study (1999) and the National Acid Deposition Precipitation Assessment Program's (NAPAP) Biennial Report to Congress An Integrated Assessment (1998), came to the unfortunate conclusion that the current and future emission reductions required by the CAAA are insufficient to protect sensitive water bodies in the Adirondacks from acidic deposition, or acid rain.

By U.S. EPA's own admission, the CAAA have been unable to satisfactorily resolve New York's great concerns with acid deposition. Given the growing body of evidence—resulting from the studies required by this Act—that the impacts of acid rain on New York's sensitive receptor areas become more devastating every day, I decided to take strong actions, ones that go well beyond the air pollution restrictions already imposed on New York State by the Clean Air Act.

The studies that I mentioned earlier—EPA's Report to Congress and the NAPAP study—provide all the evidence necessary for the Federal Government to act aggressively to curb the emissions of these pollutants far more than had been envisioned by previous regulatory actions. I am dismayed at the Federal inertia which, even with this tremendous documentation that our lakes are dead or dying at an alarmingly fast rate, continues to allow us to be ravaged by these pollutants.

Chairman Inhofe, I believe you share my philosophy that Federal intervention in the activities of the States should be limited to only those areas where the States, on their own, cannot fully address a specific issue. The interstate transport of air pollutants is one of those issues where the Federal Government must be a partner with the States to reduce pollution and to establish a level playing field.

The evidence of the reports required by the CAAA show as well that some electric generation facilities in New York State are responsible for a portion of the air pollution which damages our lakes, ecosystems, buildings, and public health. Although the pollutants emitted by New York utilities are limited—only about 20 percent of the total harmful emissions of air pollutants that result in acid rain in New York State—I was determined to act upon this information.

Since Federal action to significantly decrease air pollution in all the States which have facilities responsible for interstate transport has not been forthcoming, here in New York we will take the lead. That is why I have directed NYSDEC Commissioner Cahill to promulgate regulations that will require fossil-fueled electric generators in New York to further reduce their acid rain-causing emissions. In doing so, I am requiring utilities in New York State to reduce sulfur dioxide emissions an additional 50 percent below Federal CAAA standards, and to extend summertime nitrogen oxide controls to year round controls.

My proposal is a regulatory initiative. It will reduce airborne emissions that result in acid rain from New York's electric generators. It will require reductions in emissions of sulfur dioxide by 50 percent beyond what will be required by Phase II of Title IV of the Federal CAAA. These additional reductions will be phased in between 2003 and 2007.

Furthermore, in addition to the tremendous natural and structural losses from acid rain, millions of our residents are harmed by levels of ozone—smog—that impair human health. There are too many summer days when we have to warn our most sensitive residents—the young, the elderly, the infirm—that they shouldn't go outside and breathe the air, or that they should limit their activities. Our asthma rates, to which ozone contributes, are among the highest in the nation. Clearly this situation is unacceptable. For this reason, New York already has agreed to reduce emissions of nitrogen oxides from electric generators to 0.15 pounds of nitrogen oxides per million BTU heat input during the summer months (May through September). New York's new proposal will require this emission rate to be achieved year round.

We envision allowing statewide emissions averaging, which will encourage regulated entities to trade among themselves to achieve compliance. My proposal also will supplement the sulfur dioxide reduction program required by Federal law.

The percentages of reductions described above will translate to additional sulfur dioxide reductions of 130,000 tons per year, while the additional nitrogen oxide reductions will total 20,000 tons per year.

New York State will encourage and assist other States across the Nation to follow our lead on these innovative programs to generate additional reductions. I expect that other States will begin to follow New York's example very soon.

The annualization of the nitrogen oxide emissions rate will begin in 2003. Reductions in sulfur dioxide will begin in 2003 and will be fully implemented by January 1, 2007. Regulations must be drafted and promulgated for both pollutants. This process, which will include full involvement by the public, is expected to take at least a year.

In taking this unprecedented step, I am joined by environmental organizations across the State—including several national environmental groups—in sending a strong message to the Clinton Administration and other States: In New York, we will do all we can to clean up our air while we continue to fight for stronger clean air requirements on the national level. The League of Conservation Voters, the Natural Resources Defense Council, the National Audubon Society, the Adirondack Council, the Environmental Defense Fund, and Scenic Hudson all have endorsed this initiative.

New York's citizens deserve no less.

This is not the first time that New York's early initiative on acid rain has led the way for Federal action. In 1984, New York enacted the Acid Deposition Control Act, the first acid rain law in the country to require emission reductions. This State law identified both sulfur dioxide and nitrogen oxide as precursors to acid rain; sought limits on total emissions from utilities sited within the State; and proposed the innovative trading mechanism, mentioned earlier, which Congress would later adopt nationwide in the Clean Air Act Amendments of 1990.

The initiative which I announced earlier this month is embodied in legislation which is before your Subcommittee for review. S. 172, introduced in the Senate by Senator Moynihan, and in the House of Representatives by Representatives Boehlert and Sweeney, is intelligent and effective legislation that would require national reductions in acid rain-causing emissions. The commitment made by New York State, which I describe above, will have the same effect in our State as the Moynihan-Boehlert-Sweeney bill would have on the Nation.

I would like to point out that our entire New York Delegation is being joined by Members of Congress from other States in support for the Moynihan-Boehlert-Sweeney bill. As a result of the EPA and NAPAP studies, these other members of the Senate and House have recognized that the interstate transport of air pollutants damages the environmental quality and public health of their States as well. The tragedy that we already have seen in New York is simply the harbinger for other sensitive receptor areas across this Nation—such as Chesapeake Bay, Narrangansett Bay and Tampa Bay.

Just as the citizens of New York deserve no less than the best possible protection from acid rain, through strict emissions limits, I believe that the citizens of our Nation deserve no less. Acid rain is not just a New York problem—it is a national problem which deserves a national solution.

Experience in complying with the acid rain provisions of the CAAA has demonstrated that these reductions can be achieved far less expensively than previously thought. Modern control technology has dramatically reduced the cost of compliance. For instance, the drafters of the 1990 CAAA estimated that it would cost approximately $1,500 to reduce one ton of sulfur dioxide. Today, that cost is actually less than $200 a ton.

Chairman Inhofe, I cannot emphasize to you enough the urgency of this proposal to New Yorkers. The sources and impacts of acid rain on New York's sensitive

ecosystems have been well documented. Without serious action such as this initiative, on both the State and national level, we in New York realistically fear the loss of some of our most precious national resources. We hope, by implementing these dramatic reductions in sulfur dioxide and nitrogen oxide emissions, to demonstrate to the Administration and Congress the importance of approving the Moynihan-Boehlert-Sweeney legislation. Through our actions, we know that we have made New York the leader in the fight against acid rain and the devastation that it causes. We hope that we also are making New York an example of how cost effective and beneficial reductions in sulfur dioxide and nitrogen oxides can be.

STATEMENT OF ROBERT PERCIASEPE, ASSISTANT ADMINISTRATOR, OFFICE OF AIR AND RADIATION, ENVIRONMENTAL PROTECTION AGENCY

Mr. Chairman and Members of the Subcommittee, I welcome the opportunity today to testify on our nation's progress under the Clean Air Act (the Act) toward achieving clean, healthy air for all Americans. My remarks reflect the perspective I have gained during my time at the U.S. Environmental Protection Agency (EPA), and also my experience as the Secretary of the Environment in Maryland, and as the first State chair of the Ozone Transport Commission.

It is important to remember that the Clean Air Act Amendments of 1990 (the 1990 Amendments) passed with overwhelming support in both the House and Senate and set ambitious air pollution reduction goals. This bipartisan legislation was designed to achieve real results—and it has done so. I am pleased to report that this nation has substantially cut air pollution over the past 9 years. We have made great strides in combating urban air pollution, toxic air pollution, depletion of the stratospheric ozone layer, and acid rain. But we still have a long way to reach our goal: clean air for every American.

I will start today by describing the substantial progress we've made since 1990 in reducing air pollution. I will then reflect on what we've learned about effective and efficient ways to achieve our goals—including the benefits of stakeholder involvement, market-based policies, flexible, common-sense implementation, and the value of publicly available information. We also have learned that many predictions of high costs and infeasibility have not come to pass. In fact, for many air pollution problems, reductions have been made faster and at less cost than we ever expected. Finally, I want to bring you up to date on some of our key current efforts and talk briefly about whether the Clean Air Act should be reopened at this time.

PROGRESS TOWARD CLEAN AIR

To appreciate how far we have come in reducing air pollution, it is instructive to remember where we were before the 1990 amendments. There was growing concern about the increasing damage to the stratospheric ozone layer, which, among other things, protects us from skin cancer and cataracts. Acid rain essentially was unchecked, causing damage to aquatic life, forests, buildings and monuments, as well as visibility degradation and health risks from sulfate and nitrate particles. In 1990, photochemical smog, which can impair lung function, cause chest pain and cough, and worsen respiratory diseases and asthma, exceeded healthy levels in 98 metropolitan areas. Many cities did not meet the national air quality standards for the pollutant carbon monoxide, which can aggravate angina (heart pain), and also for particulate matter, which is linked to premature death, aggravation of pre-existing respiratory ailments, and reductions in lung capacity. The millions of tons of hazardous air pollutants emitted annually in the United States were largely unregulated at the Federal level. Many of these pollutants have the potential to cause cancer or other serious health effects such as nervous system damage, miscarriages or birth defects.

Since then, the 1990 Amendments enabled us to substantially reduce each of the major air pollution problems that faced the United States:

Annual sulfur dioxide emissions, which react to form acid rain, have been cut by more than 5 million tons, and rainfall in the eastern United States is as much as 25 percent less acidic.

Production of the most harmful ozone-depleting chemicals has ceased in the United States and—provided the United States and the world community maintain the commitment to planned protection efforts—the stratospheric ozone layer is projected to recover by the mid 21st century.

Ground-level ozone pollution, particulate matter, and carbon monoxide pollution have all been reduced significantly, producing dramatic decreases since 1991 in the number of areas in nonattainment.

Rules issued since 1990 are expected to reduce toxic emissions from industry by 1.5 million tons a year—eight times the reductions achieved in the previous 20 years.

These results have been achieved through a combination of rules, voluntary measures, market mechanisms, State partnerships, and stakeholder negotiations. Between 1990 and 1997, we reduced annual emissions of all criteria pollutants by 10 million tons. By 2010, rules already in place will have reduced these annual emissions by more than 30 million tons from the 1990 level.

REDUCING ACID RAIN

To combat acid rain, the 1990 Amendments called for a 10 million ton reduction in sulfur emissions, relative to a 1980 baseline. Much of that was to be achieved from utility power plants through an innovative market-based pollution allowance trading system. The results have been dramatic. So far, national sulfur dioxide emissions have been cut by more than 5 million tons, mostly through this program—and at lower cost than predicted. As a result, rainfall in the eastern United States is up to 25 percent less acidic, and some ecosystems in New England are showing signs of recovery. Separate requirements for nitrogen oxides controls for utilities already have begun reducing those emissions, and will achieve a 2-million ton NOx reduction beginning next year.

Annual costs of the sulfur emissions program are now estimated to be less than half of what we projected in 1990 ($4 billion in 1990, $1 to $2 billion now). Trading has allowed the utility industry to minimize compliance costs, and has spurred competition in other sectors of the economy such as freight, coal, and scrubbers—all of which has resulted in lower costs. The rest of the 10 million ton reduction in SO_2 will be achieved by 2010 through the second phase of the acid rain program. Recent research indicates that further reductions in SO_2 and NOx emissions beyond those required by the acid rain program would be necessary for full recovery of the most sensitive ecosystems. The controls to achieve such reductions also would provide significant health benefits by reducing fine particulates.

PROTECTING THE STRATOSPHERIC OZONE LAYER

The global phase-out of chlorofluorocarbons (CFCs) and other ozone-depleting chemicals is an unparalleled triumph of the soundest science, economics, and diplomacy. It rests on an overwhelming consensus within the world science community. One hundred and sixty-eight nations have become parties to the Montreal Protocol, the treaty through which the phase-out policy is being implemented worldwide. The United States and the world have made significant progress to date in addressing the erosion of the earth's protective ozone layer by eliminating many manmade ozone-depleting chemicals. Production of the fire-extinguishing halons was virtually eliminated by the world's developed countries in 1994 and at the beginning of 1996, developed country production of CFCs, methyl chloroform, and carbon tetrachloride ended, thus avoiding emissions of 400,000 metric tons of ozone-depleting substances. As a consequence of these prudent international actions, the rate of increase of atmospheric concentrations of ozone-depleting chemicals has slowed, and in some cases, declined. In 1998, more than 100 scientists worldwide collaborated in a scientific assessment of the state of the ozone layer. These scientists concluded that the Montreal Protocol is working. Reductions in concentrations of ozone-depleting compounds already have been measured in the atmosphere, and scientists predict the gradual recovery of the ozone layer by the mid-21st century.

This unprecedented international success story also will contribute substantially to the health of all Americans. EPA estimated in 1992 that the phase-out would reduce U.S. incidences of non-melanoma skin cancer by 295 million during the period 1989 through 2075, as well as protect people from eye damage leading to cataracts, and immune system suppression .

The phase-out used a market trading approach developed by EPA that has served as a model for programs in other countries. Because of strong partnerships with industry and the flexible market approach, the phase-out was much less expensive than was predicted at the time the 1990 Clean Air Act Amendments were passed. In 1988, EPA estimated that a 50 percent reduction of CFCs by 1998 would cost $3.55 per kilogram. In 1993 the cost for a 100 percent phase-out by 1996 was down to $2.45 per kilogram.

HEALTHIER AIR IN MORE CITIES

The air in our nation's cities is substantially cleaner than in 1990. Nationally, the 1997 average air quality levels were the best on record for all six common pollutants (lead, NO_2, SO_2, PM_{10}, CO and ozone) subject to air quality standards. The 1998

levels were as good or better for all pollutants except ozone. These improvements have occurred along with growing population, strong economic growth and continued growth in vehicle miles traveled. From 1970 to 1997, U.S. Gross Domestic Product has grown by 114 percent, the U.S. population has grown by 31 percent, and the number of miles traveled by on-road vehicles (VMT) has increased by 127 percent.

Since 1993, an unprecedented number of cities have met the health-based national ambient air quality standards. For example, of the 42 carbon monoxide areas designated as nonattainment in 1991, only 6 areas continue to experience unhealthy levels of CO (based on 1996 –1998 data). Much of the progress on CO can be attributed to the Clean Air Act's wintertime oxygenated fuels program, which began in 1992 in 30 cities.

Although we continue to experience unhealthy levels of ozone and particulate matter, we have made substantial progress even with those pollutants. The 1996 to 1998 data for particulates indicates that 71 of the original 85 nonattainment areas have air quality meeting the PM_{10} standard. Average particulate levels (PM_{10}) dropped 25 percent from 1989 to 1998. Because we now believe that the finer particles pose the greatest health concern, we are working with States to get monitoring systems in place for fine particulate matter ($PM_{2.5}$). In the case of ground-level ozone, based on 1996 to 1998 data, 62 of the original 98 ozone nonattainment areas have air quality levels meeting the 1-hour ozone standard.

For the other three criteria pollutants, few areas remain in nonattainment. The remaining lead and sulfur dioxide nonattainment areas in the country are the result of localized point sources for which action on an individual basis is being taken. The nitrogen dioxide standard is now met nationwide. The last nitrogen dioxide nonattainment area, Los Angeles, met the standard in 1992 (and was redesignated to attainment in 1998).

CLEANER CARS, CLEANER FUELS

A key reason for the air quality improvements we are seeing is that the 1990 Amendments called for cleaner motor vehicles and cleaner fuels, in recognition of the important role that motor vehicle emissions play in affecting air quality.

Today, the average new car (meeting Tier I standards in the 1990 Amendments) is 40 percent cleaner than the average new car was in model year 1990. Cars now have onboard canisters to control refueling vapors, and onboard diagnostic computers to identify emission control problems.

In 1997, EPA mediated an agreement among the States, U.S. auto companies, and other stakeholders that calls for automakers to produce cars 50 percent cleaner than today's Tier I cars, which began in eight Northeastern States in model year 1999. In addition to covering passenger cars, the agreement covers the majority of sport utility vehicles, minivans, and light-duty trucks, which have higher emissions than cars. Automakers voluntarily agreed to meet the tighter standards on an enforceable basis. The agreement benefits car companies by avoiding a potential patchwork of differing State emissions requirements. It benefits States and the public by delivering cleaner cars 5 years sooner than EPA could otherwise have required. These vehicles will be available nationwide in model year 2001.

While requiring cleaner cars, the 1990 Amendments also required cleaner gasoline. To reduce smog-forming VOCs and toxics, the 1990 Amendments required cleaner, reformulated gasoline in the worst ozone areas, and allowed additional areas to join the program. Today, 30 percent of the country's gasoline consumption, in 18 States, consists of reformulated gasoline, or RFG. Overall, refiners have gone beyond the 15 percent reduction in VOCs and toxics required by the Act beginning in 1995. Refiners' data now tell us that VOC reductions are 8 percent greater than required on average, and toxic reductions almost twice the required amount. In those RFG areas where we measured, levels of benzene in the air were down 43 percent from 1994 to 1995. This is exciting progress since benzene is a known human carcinogen that has been linked to leukemia. One of the attractive features of this program is that reductions of pollutants are immediate because cleaner fuels can be used in any car on the road today. Phase II of the RFG Program will begin in January 2000.

Buses and trucks also are getting cleaner. Diesel-powered urban transit buses being built today release almost 90 percent fewer particulate emissions than buses built in 1990. As a result of EPA emissions standards for new buses, smoke-belching buses will disappear as old buses are retired from service. Emissions control will be required for older urban buses that have their engines replaced or rebuilt. Under rules issued in 1997, NOx emissions from heavy-duty diesel engines used in trucks and buses will be cut in half by 2004, assisting with efforts to reduce smog and particulates. In addition, substantial emissions reductions are being achieved for the

first time through a set of standards for a variety of engines not used in highway vehicles—including locomotives, bulldozers, commercial and recreational marine vessels and lawn and garden equipment.

In addition to the very substantial reductions in ozone precursors, all of the programs put in place since 1990 to control emissions from motor vehicles will reduce total vehicular air toxics emissions by approximately 40 percent.

CUTTING INDUSTRIAL AIR TOXICS

Since 1992, EPA has issued 43 pollution standards affecting 70 industrial categories such as chemical plants, dry cleaners, coke ovens, and petroleum refineries. When fully implemented, these standards will eliminate over 1.5 million tons of air toxics and over 2.5 million tons of particulate matter and smog-causing volatile organic compounds.

By contrast, in the preceding 20 years only seven hazardous air pollutant standards, eliminating 125,000 tons of toxics, had been put in place. One of the main reasons was that the toxics provisions of the 1970 Act triggered contentious debates and litigation over risk assessments and "how safe is safe." Congress resolved this in 1990 by directing EPA to issue technology- and performance-based standards on a source category basis to ensure that major sources of air toxics are well controlled. These standards create a level playing field by requiring all major sources, in essence, to achieve the level of control already being achieved by the better performing sources in each category.

The result is that we are reducing the large quantities of toxic air pollutants released into our air, in the aggregate and around industrial sources in populated areas. We will achieve additional reductions as we complete standards for more categories of major pollution sources. We are now in the early stages of implementing the second phase of the air toxics program outlined by the 1990 Amendments, targeting particular problems such as elevated risks in urban areas, deposition of air toxics into the Great Lakes, mercury emissions, and residual risks from already controlled sources.

IMPROVING VISIBILITY IN OUR NATIONAL PARKS AND WILDERNESS AREAS

In July, EPA published a new rule calling for long-term protection of and improvement in visibility in 156 national parks and wilderness areas across the country. These areas include many of our best known and most treasured natural areas, such as the Grand Canyon, Yosemite, Yellowstone, Mount Rainier, Shenandoah, the Great Smokies, Acadia, and the Everglades. Regional haze, created by fine particles and other pollutants, degrades vistas in these parks and regionally across the nation. For example, on some days air pollution reduces visibility to less than 10 miles in our eastern parks.

The regional haze program is designed to improve air quality in the parks, particularly on these poor visibility days. Because haze is a regional problem, EPA is encouraging States to work together in multi-State planning organizations to develop potential regional strategies for the future. EPA will be working closely with these multi-State organizations, to provide guidance during this process, just as it did with the many States and Tribes involved in the Grand Canyon Visibility Transport Commission.

During the period 2003–2008, States are required to establish goals for improving visibility in each of these 156 areas and adopt emission reduction strategies for the period extending to 2018. States have flexibility to set these goals based upon certain factors, but as part of the process, they must consider the rate of progress needed to reach natural visibility conditions in 60 years. To assist in evaluating regional strategies and tracking progress over time, we are working with the States and Federal land managers to expand our visibility and fine particle monitoring network to 110 of these areas over the next several months.

WHAT WE'VE LEARNED: INNOVATIVE STRATEGIES AND STAKEHOLDER INVOLVEMENT

These impressive results have come about through involving stakeholders from the outset, using innovative and flexible environmental protection strategies, and adjusting when programs need improvement.

Since 1990, the Agency has dramatically expanded its interaction with stakeholders. Consensus is not always attainable, of course. But the time and effort we put into communication and consensus-building pays off in better rules, and often in smoother implementation.

One of the first examples of stakeholder involvement was the Acid Rain Advisory Committee, an intensive 7-month effort with stakeholders immediately after the 1990 Amendments that helped shape the rules for the successful acid rain program.

This positive experience led to establishment of the Clean Air Act Advisory Committee, a standing group of several dozen experts from industry, the environmental community, States, academia and elsewhere. We seek the advisory committee's insights frequently.

Two large stakeholder involvement efforts were the Ozone Transport Assessment Group (OTAG) process and the National Ambient Air quality Standards (NAAQS) implementation advisory committee process. OTAG, which involved 37 States, EPA, and many stakeholders, conducted state-of-the-art modeling to improve understanding of the interstate ozone transport problem in the East, and laid the groundwork for our ongoing efforts to institute regional controls on NOx emissions. EPA supported OTAG, which was led by the Environmental Council of States, with significant technical and financial assistance. The NAAQS Federal Advisory Committee Act (FACA) process, convened by EPA, provided us with insights on ways to implement the 1997 ozone and PM NAAQS even before those standards were promulgated.

Since 1990, we typically have involved stakeholders earlier in rulemaking efforts than we did before that time. In the case of air toxics standards, for example, we realized that working with stakeholders early in the process would be a necessity if we were to meet the Act's requirement to produce standards for the long list of industrial source categories. We developed a "MACT partnering" process that allows EPA, State and local air quality agencies to work cooperatively with industry and local organizations to collect information on emissions and controls, and to develop a draft determination of the level of control. Similarly, we have engaged stakeholders in substantive discussions prior to developing proposed mobile source rules—for example, in developing rules to control emissions from heavy-duty trucks and buses. The National Low Emission Vehicle Program is another example of what can be achieved through consensus building with stakeholders when incentives for agreement exist.

Since 1990 we have emphasized using new approaches to achieve more environmental protection at less cost. We have made increasing use of market-based approaches to cut compliance costs, promote technology development and achieve extra environmental benefits. We also have looked for other ways to provide flexibility on the means of achieving emissions reductions, while ensuring accountability. We are making use of new information technologies to improve public information on air quality, and are providing compliance assistance to small businesses.

Emissions averaging and trading are frequently used as standard tools of the air program. Beyond the stratospheric ozone and acid rain programs, we have provided trading opportunities in many national air rules for vehicle manufacturers and fuel refiners. The most recent example is the proposed Tier II/gasoline sulfur rule, which would allow averaging, banking and trading to provide additional flexibility to vehicle manufacturers and fuel providers. Emissions averaging is permitted by national air toxics emissions standards for refineries, chemical plants, aluminum production, wood furniture and other sectors that use coatings. We also have used other methods, including multiple compliance options, to help provide flexibility in air toxics rules.

In addition to providing flexibility in national rules through trading and other means, EPA is working with States to promote market-based approaches to help achieve national air quality standards for smog, particulates and other criteria pollutants. EPA has issued guidance to assist States in designing trading and other economic incentive programs to reduce criteria pollutants, and will soon update that guidance. EPA also has assisted States in setting up trading programs, such as California's RECLAIM program for reducing sulfur dioxide and nitrogen oxide emissions and the Ozone Transport Commission's program for controlling nitrogen oxide emissions among States in the Northeast. Through a unique State-EPA partnership, we are jointly implementing this NOx budget system for the Northeast.

In issuing NOx budgets for 22 States and the District of Columbia to reduce the problem of transported ozone pollution in the East, we provided a model cap-and-trade rule for utilities and large industrial sources. The experiences of the acid rain program and the OTC effort show that this approach holds the potential to achieve regional NOx reductions in an efficient and highly cost-effective manner.

The air program is striving to provide flexibility and create incentives for reducing emissions in a variety of ways. A number of air toxics rules—including those addressing polymers and resins, primary aluminum, and pharmaceuticals manufacturing—provide companies the opportunity to reduce reporting requirements if they achieve consistent good performance. We have issued guidance to allow States to count voluntary measures to reduce emissions from transportation sources—such as ridesharing programs and ozone action days—toward their State planning requirements under the Act.

This is the information age, and we are finding ways to use the new information technologies to provide citizens with environmental information they can use. Here are three examples:

- The Ozone Mapping Project, or AIRNOW, provides the public for the first time with real-time information about smog levels in their communities via color-coded maps and animations. These maps are made available on an Internet website and for local TV weather reports.
- E-GRID, the Emissions & Generation Resource Integrated Data base, is a right-to-know tool for anyone interested in emissions or fuel mix of any portion of the nation's electric power grid. It combines in one data base information from EPA and the Energy Information Administration on power generation, fuel information and measured emissions.
- The EPA funded SUNWISE Schools Program is building a national UV monitoring and education network within U.S. elementary schools. Using the Internet, students report the UV Index, a daily forecast of UV radiation levels people might experience, and recommended UV-protective behaviors. This innovative approach to sharing real-time environmental information with the public is a helpful tool in protecting the health of our children from overexposure to UV radiation while the ozone layer recovers.

Another information-related development during the 1990's is the establishment of Clean Air Act small business technical assistance programs and small business ombudsmen in every State. These programs help small businesses comply with the Clean Air Act by providing free technical assistance. In 1997, State programs directly assisted over 78,500 businesses and conducted almost 6,000 onsite consultations for a wide variety of industry sectors. To cite one success story: One Texas furniture company, after consulting with the State, invested $8,000 in more efficient, high-volume, low-pressure spray guns and related equipment and trained employees in their proper use. These guns spray more of the paint onto the product and less onto the floor and into the air. As a result, the firm's smog-forming VOC emissions dropped from just under 25 tons in 1996 to 16 tons in 1998, while its annual spending on paint and coatings fell from $69,000 to $35,000.

In addition to these efforts, we have worked to continually refine and improve our implementation programs. The following examples show our willingness to make adjustments when programs need improvement.

We recently overhauled our long-established process for evaluating whether new cars and light-duty trucks meet emissions standards. The revised rules will save auto manufacturers an estimated $55 million annually, while providing better information on whether cars on the road are continuing to meet the standards. The vehicle emission Compliance Assurance Program, or CAP 2000, redirects the focus of EPA and automakers from pre-production laboratory demonstrations to verification of actual in-use performance. This reduces paperwork by 50 percent, as well as saving valuable pre-production time. In exchange, industry will conduct extensive emissions testing of vehicles "in use" on a broader scale than the government could conduct. This will give automakers substantial incentives to ensure that their vehicles meet the standards in actual use.

We are moving forward in our efforts to improve the new source review permitting program. This program ensures that pollution from the addition of major new and modified sources does not significantly degrade the air quality in clean air areas, and that the national ambient air quality standards in non-attainment areas can be achieved. A key objective of our efforts is to streamline permitting without sacrificing environmental and other benefits of the current program. The new source review reform package will provide options for sources and States to adopt more flexible approaches to meet new source review requirements so that companies can plan and implement anticipated changes at their facilities with a greater degree of regulatory certainty. Concurrently, some of the reform measures will enhance environmental protection in some of the nation's most sensitive Class I areas, which include many of our national parks. We are nearing completion of an intensive set of stakeholder meetings that we expect will be very helpful when finalizing the reform package. Our schedule for finalizing the rule has been reset for spring 2000 to allow us to evaluate what we have learned from recent interactions with stakeholders.

To address concerns raised about the Title V operating permits program, we issued two guidance documents that streamlined and simplified permit applications and helped with the large job of issuing initial permits to all covered facilities. We also continue to work toward finalizing a proposed permit revisions rule, where we are working closely with stakeholders to avoid unnecessary permit revision delays for industry while addressing citizens' interest in public review of significant changes.

We continue to develop and test innovative ways to allow companies to adjust quickly to market demands without experiencing permitting delays. To date, we have worked with companies and States on approximately a dozen permits designed to provide operational flexibility and promote pollution prevention. Three permits have been issued to date and eight more are in progress.

For example, working in conjunction with EPA and other stakeholders, the Intel Corporation was able to develop a flexible permit that allowed the company to receive advance approval for several types of operational changes at its facility in Oregon. As a result, Intel was able to avoid permitting delays and significant staff time. Additionally, Intel cut its air emissions in half while doubling production onsite. We are also planning to document the lessons learned from these permits so that successful flexible permitting approaches can be replicated throughout the country.

WHAT WE'VE LEARNED: PREDICTIONS ABOUT INFEASIBILITY AND COST

Throughout the history of the Act, some critics have made dire predictions about the infeasibility of proposed controls or the negative impact that the Clean Air Act would have on industries, jobs and the U.S. economy. Nearly 9 years after the 1990 amendments, we have achieved progress in cleaning the air without the severe dislocations predicted by some critics. Experience shows that progress toward clean air and economic growth can go hand in hand. For example, data from the Bureau of Economic Analysis shows that between 1990 and 1995, there was a net gain of 2.2 million jobs in ozone nonattainment areas (a few were excluded due to data constraints).

REVIEWING THE RECORD

Costs of the 1990 Amendments are proving to be far less than initial industry estimates. For example:

- The Clean Air Working Group, a key industry lobbying group during the 1990 reauthorization effort, estimated in August 1990 that compliance costs would total $51 billion to $91 billion annually. Today, with the benefit of the added information from several years of implementation, EPA estimates the annual cost at $26.8 billion upon full implementation of the law in 2010.
- An industry study in 1989 predicted the cost of fully implementing an acid rain program at $4.1 billion to $7.4 billion. More recent estimates by EPA and the U.S. General Accounting Office were approximately $2 billion, and estimates from independent economists and industry researchers range as low as $1 billion.
- In 1993, industry estimated that meeting the Act's requirements for reformulated gasoline would add 16 cents to the price of a gallon of gas. In 1995, the year the program took effect, an Energy Information Administration survey found the actual cost was 3 cents to 5 cents per gallon.

Another concern of industry representatives during the 1990 reauthorization was that it would be technologically infeasible to comply with some requirements. For example, a chemical company spokesman testified that accelerating the phase-out of ozone-depleting CFCs to January 1996 would cause severe economic and social disruption. At the same hearing, a refrigeration industry representative testified, "We will see shutdowns of refrigeration equipment in supermarkets. . . .We will see shutdowns of chiller machines, which cool our large office buildings, our hotels, and hospitals." In fact, the phase-out of CFC production was accomplished without such disruptions. Chemical companies helped make this possible by rapidly developing alternatives to CFCs.

Similarly, a major American auto company representative in 1989 testified that "we just do not have the technology to comply" with the initial Tier I tightening of tailpipe standards that became part of the 1990 amendments. Nonetheless, the auto industry was able to begin producing vehicles meeting the standards in 1993. More recently, as previously mentioned, the auto industry entered into a voluntary agreement with EPA and States to produce even cleaner, low emission vehicles that are already being sold in some areas.

As these examples begin to illustrate, Clean Air Act requirements have created market opportunities and pressures for technology breakthroughs and performance improvements. Over and over again, industry has responded with great success, producing breakthroughs such as alternatives to ozone-depleting chemicals and new super-performing catalysts for automobile emissions. The result has been affordable improvements in air quality across the country, in conjunction with continued economic and population growth. There are many examples of technologies that were not commercially available 10 years ago, but that now are important parts of pollution control programs. Some of these include reformulated gasoline, selective cata-

lytic reduction for NOx emissions from power plants, and cleaner-burning wood stoves. This pattern of technological progress is continuing today. EPA has identified a number of emerging technologies—ranging from fuel cells to ozone-destroying catalysts to new coating technologies—that may hold promise for achieving additional cost effective reductions of VOC, NOx and particulate matter.

BENEFITS V. COSTS

Some have charged that the costs of the Act exceed its benefits. But the most exhaustive study of this issue to date, an EPA study required by Congress, finds otherwise.

Under section 812 of the 1990 amendments, we are required to assess the costs and benefits of the Act, first retrospectively and then with an ongoing series of prospective studies. The retrospective study, published in October 1997, included estimates of the number of incidences of health effects avoided in 1 year—1990—due to Clean Air Act pollution reductions. Here are estimates for a partial list of the avoided health effects:

- 184,000 incidences of premature mortality and 8,700,000 incidences of acute bronchitis related to particulates;
- 10,400,000 lost IQ points and 12,600,000 incidences of hypertension related to lead;
- 68,000,000 incidence-days of shortness of breath, 850,000 incidences of asthma attacks, and 130,000,000 incidences of 19 acute respiratory-related symptoms related to particulates and ozone;
- 39,000 incidences of congestive heart failure related to particulates and carbon monoxide; and
- 22,600,000 lost work days related to particulates, and 125,000,000 days with restricted activity due to particulates and ozone.

The section 812 retrospective study found that the 1970 and 1977 Clean Air Acts yielded human health, welfare and environmental benefits that exceeded costs by more than 40 to 1 ($22.2 trillion versus $523 billion). Even at the low end of our range of estimates, monetized benefits exceeded costs by a margin of 11 to 1. EPA is now nearing completion of the first prospective study examining the incremental value of the 1990 amendments. Separately, EPA completed a cost/benefit assessment of the acid rain program in 1995, and found the health benefits alone far exceeded annual costs.

It is important to note that the section 812 and acid rain studies determined that monetized benefits substantially exceeded costs even though many benefits could not be translated into dollars. Even with continuing progress in scientific and economic research, more than half of the known adverse effects of air pollution still cannot be expressed in economic terms. For ozone, some of the examples cited in the 812 study include lung inflammation, chronic respiratory diseases, immune system changes, forest and ecological effects, and materials damage. Given this problem, it is important not to judge the value of additional environmental and public health protections solely on the basis of monetized costs and benefits.

This is one reason for EPA's consistent position that cost-benefit analysis should not be the basis for our air quality standards. We continue to believe that our national air quality standards represent important health-based goals for the nation, and a benchmark for citizens interested in whether their air is safe to breathe. Although air quality standards are set solely on the basis of protecting health, we of course agree that cost is important to consider in devising environmental protection strategies. Costs are taken into account in implementation of the standards, as States and EPA make decisions on how to reach the goal.

WHERE WE STAND TODAY: UNFINISHED BUSINESS

As you know, we received an adverse Federal court decision in May that has stalled implementation of the new, more protective health standards EPA established in 1997 for ozone and fine particulate matter. A three-judge panel of the U.S. Court of Appeals for the District of Columbia Circuit remanded EPA's action on the two standards, challenging EPA's legal rationale as well as EPA's authority to enforce any new ozone standard under the 1990 amendments. The court did not challenge the underlying science. In light of the executive branch's strong disagreement with the ruling, the Department of Justice filed a petition for rehearing by the full court on June 28, 1999. We await the court's decision on whether to rehear the case. We continue to believe these standards are essential for protection of public health, and ultimately will be implemented. We recognize, however, that it will take some time for the legal issues to play out.

In the meantime, the Administrator and I are determined to keep emission reduction efforts on track and to reduce health threats from smog and particulate matter. We are concerned that progress on the smog problem appears to have slowed or stopped in a number of areas in the last couple of years—and in some areas, we are in danger of backsliding. The national average ozone level increased 5 percent in 1998. Also, in recent summers we have seen increases in the number of times air quality exceeded national standards in certain cities and national parks, particularly in the East. Partly because of this concern, this Administration, in partnership with States, is taking several actions to ensure that we continue making progress. Specifically:

Tier II/Gasoline Sulfur. We are on track to issue more stringent Tier II emissions standards for cars and light-duty trucks along with rules to cut levels of sulfur in gasoline. Many metropolitan areas need the emissions reductions from these rules to achieve healthy air. These rules will cut emissions that contribute to ground-level ozone pollution and particulate matter, acid rain, crop damage and reduced visibility.

Regional NOx Reductions. We will soon take final action on petitions from eight northeastern States calling upon EPA to impose NOx controls on power plants and large industrial combustion sources in 12 upwind States. This action would reduce long-range transport of NOx and ozone pollution that is contributing to nonattainment problems downwind, as well as reducing pollution in States where the sources are located. EPA also will propose action on four petitions it has recently received from Delaware, Maryland, New Jersey and the District of Columbia.

Last October, EPA issued the NOx State Implementation Plan (SIP) call rule requiring 22 eastern States and the District of Columbia to cut NOx emissions to reduce transported ozone pollution that is contributing to nonattainment problems throughout that region. States have relied on those reductions in devising their attainment plans for serious and severe ozone areas. However, shortly after issuing its NAAQS opinion, the court of appeals for the D.C. Circuit stayed the deadline for States to submit plans for complying with the NOx SIP call pending further order of the court. Oral arguments in the litigation are set for November 9.

Ozone Attainment SIPs. For 10 serious and severe ozone nonattainment areas, EPA currently is assessing State plans for demonstrating attainment of the 1-hour ozone standard. It appears that many of these areas will need to commit to additional emissions control measures and/or make other improvements in their plans before these plans are approvable. EPA tentatively plans to propose action on these plans in late November.

Heavy Trucks and Buses/Diesel Sulfur. Just last week Administrator Carol Browner announced a strategy to reduce by more than 90 percent harmful levels of smog-causing NOx and particulate matter, or soot, from heavy duty trucks and the very largest sport utility vehicles. The strategy includes a plan to produce cleaner diesel fuel.

In addition, we are seriously considering reinstating the old 1-hour ozone standard nationwide. Since issuing the more protective 8-hour ozone standard, EPA has revoked the 1-hour standard in much of the country (wherever ozone levels met the old standard). But the court opinion now leaves much of the Nation without an adequately enforceable standard for ground-level ozone pollution to guard against deterioration in air quality. We are concerned about that possibility in light of recent air quality data.

Looking more broadly to the future, we see implementing the 1997 fine particulate standard as an integrating strategy that is key to making progress on multiple pollution problems. From a health standpoint, particulate matter is a priority because of its serious health effects. But there are other benefits to controlling pollutants that react in the atmosphere to form particulate matter—specifically, sulfur dioxide and nitrogen oxides. These measures also will reduce ozone pollution, air toxics, acid rain, regional haze and visibility impairment in our national parks, and nitrogen eutrophication of coastal waters. In contrast to other pollutant trends, NOx emissions are higher than in 1970. Given the important contribution NOx makes to multiple environmental problems, we need to bring these emissions down.

In the air toxics arena, we are looking ahead to working with States and localities to implement the new Integrated Urban Air Toxics Strategy, issued in July. This strategy provides a framework for addressing the multiple sources of air toxics that together emit a combination of pollutants into our urban air. As you know, EPA has and will continue to develop national standards for stationary and mobile sources that improve air quality in both urban and rural areas. This new component of the national air toxics program includes plans for further reductions in toxic air emissions in urban areas, targeting 33 pollutants that pose the greatest health threat

in those areas. Also included are assessment activities to improve our understanding of the health and environmental risks posed by toxics in urban areas.

Regarding the question whether it is time to re-open the Clean Air Act, it is important to ask if the law is still on target given today's air quality needs. We believe the law is still on target. Because the 1990 Amendments were so forward-thinking and comprehensive in scope, it established this country's air pollution agenda for well into the next century.

Because the Act is still relevant for today's needs, and because we are at a critical stage in implementation on a number of issues, we should carefully consider the implications of reopening the Act at this time. History shows that reauthorization of the Clean Air Act is a long and difficult task. The last time around, reauthorization efforts first began in 1981, and did not culminate until 1990. This reflects the fact that many parts of our society have a strong stake in the Act, and it can take intensive efforts to find common ground on a large number of issues. There is no guarantee that a reauthorization effort could be limited to a few issues. Many groups would promote proposals they believe should be a high priority. Although the Subcommittee would be pressed by some interests to pare back the requirements of the Act to cut costs, we can also be sure there there will be efforts to strengthen the Act and broaden its authorities, to ensure that we deliver on the promise of clean air for every American.

We are prepared to work with the Subcommittee on a process of reviewing the Clean Air Act to consider where it might benefit from improvements. An example of an issue that this process could examine is whether the Act should provide EPA with direct authority to establish multi-State cap-and-trade programs and other incentive-based programs to address regional problems for any pollutant. This would avoid the need for each State separately to enact compatible trading programs. Let me stress that once this review process is completed, we must assess whether reopening the Act would be more helpful or more disruptive on the whole.

It is imperative to continue the work that already is in motion. The best way to do that is to stay focused on the goal and work with everyone affected by the Act. This has and will continue to dramatically improve our ability to find sensible, cost-effective solutions to implementation hurdles and minimize the need for statutory changes. This approach takes time and patience, and sometimes the process is frustrating, but it has proven to pay off with sensible policies and environmental results.

Thank you. I would be happy to answer any questions that you may have.

RESPONSES BY ROBERT PERCIASEPE TO ADDITIONAL QUESTIONS FROM SENATOR THOMAS

Question 1. The Clean Air Act Amendments of 1990 created the Title V Operating Permit Program. The Operating Permit Program purportedly was not to establish any new requirements. However, in Wyoming, this new program has added significantly to the amount of time it takes to get a permit. The first step is to obtain a State-issued construction permit, which requires public notice and comment. The permittee must then request a modification of the Title V Operating Permit, and once again go through public notice (for the exact same thing!) Once that step is taken, EPA then has 45 days to review and have the opportunity to veto the permit. It appears that this process is being overseen by the Department of Redundancy Department. What are the opportunities for streamlining the process, while maintaining State primacy for the review and issuance of the permits (i.e., EPA doesn't take over the whole process)?

Response. Your question references two separate State permitting programs required by the Clean Air Act—preconstruction permit programs, also known as "new source review" (NSR) programs, and operating permit programs under Title V.

EPA believes it is possible for States to merge the required EPA and public review periods (for sources subject to both programs), as long as the merged review is adequate to meet the goals of both NSR and Title V. The EPA has encouraged States to do so, and has approved merged programs under the current title V regulations. However in keeping with principles of State primacy, the EPA does not require States to merge review. In practice, some States have merged programs while others have not. We would welcome working with Wyoming on such a merger.

Preconstruction permit programs and Title V operating permit programs have different purposes. An NSR preconstruction permit establishes control requirements for a source that is being built or modified. A Title V operating permit consolidates in one place all of the air pollution requirements (including NSR requirements) that apply to a large facility, and specifies how compliance will be demonstrated. This

clarifies for the regulated facility and the public the air pollution requirements that apply to the facility, encouraging improved compliance.

Question 2A. There are a number of routine repair and replacement upgrades that utilities can undertake to improve their efficiency thereby resulting in lower NOx emissions per unit of electricity generated and substantially reducing global warming gases like CO_2. Unfortunately, it is my understanding that EPA's interpretations of its current regulations, and the EPA's failure to finalize its position on these issues for its new regulations on new source review, are discouraging utilities from undertaking these improvements that are good for the economics of the utility and the environment. It seems counterproductive to discourage these efficiency improvements while the EPA is working through its rulemaking process. Does EPA believe that utilities must replace parts with the exact original technology that was installed in a turbine or boiler at the time that the unit was manufactured or are these plants allowed to use the advancements in technology that every industry has seen over the past several years?

Response. Projects that involve routine repair and replacements are exempt from major new source review (NSR). This has been a longstanding provision of the NSR rules, and there are no proposals to change this exemption. In addition, under the current major NSR regulations, a utility may make any type of change to an existing unit, including new technology that improves efficiency, to the extent that the change does not increase actual tons-per-year emissions by a significant amount over the baseline period established in the regulations. Finally, the utility may still make the improvement and increase emissions, as long as it installs the best currently available pollution control technology at the time.

The Clean Air Act recognizes that if a unit is undergoing modifications that will generate more air pollution, then that is the best time to install new pollution control equipment.

The Clean Air Act Amendments of 1977 did not require updated pollution controls for many aging utility facilities. Many of these old boilers have not been retired. So while other sources reduced air emissions over the past 20 years, some utilities continued to operate using pollution control equipment from the 1950's and 1960's.

In the more than two decades of the NSR program, the EPA has worked with the States and industry to reduce air pollution from existing facilities at the time it is most cost-effective to do so when a modification that will increase emissions is occurring. EPA, States, and other groups are available to answer questions or clarify regulations if a source is uncertain about whether a specific project would fall under the NSR program.

Question 2B. What do you plan to do to solve this problem under the current regulations and how will your new regulations address these much-needed efficiency improvements?

Response. As noted above, the current regulations already allow utilities to upgrade their equipment without review, including making efficiency improvements, as long as the upgrade does not significantly increase actual tons-per-year emissions.

Question 2C. If you cannot solve this problem through your regulations, do you think that legislative action would be appropriate to provide EPA with flexibility to address these concerns?

Response. The EPA does not believe that legislative action is needed at this time to address concerns about efficiency improvements. The current regulations do not prevent a utility from making efficiency improvements . They simply ensure that where any type of change significantly increases actual tons-per-year emissions, appropriate control technology is applied.

Question 3. What is EPA's schedule for acting on the section 126 petition targeting NOx sources? Isn't it true that the factual basis for EPA's NOx SIP call and for the section 126 petitions that EPA has received targeting specific sources of NOx are essentially the same? Why then does EPA not await judicial review of the SIP call prior to acting on the section 126 petitions?

Response. EPA generally granted the petitions from Connecticut, Massachusetts, New York, and Pennsylvania on December 17, 1999, and established control requirements for certain NOx sources in upwind States. In that final rule, EPA made section 126 findings based on the 1-hour ozone standard and stayed the portion of the rule based on the 8-hour ozone standard.

The EPA denied petitions for the 1-hour ozone standard filed by Maine, New Hampshire, Rhode Island and Vermont in April 1999 because these States no longer had areas that were not attaining the 1-hour standard. The EPA is reviewing section 126 petitions submitted in 1999 by New Jersey, Delaware, the District of Co-

lumbia, and Maryland. When the review is complete, the Agency intends to issue a proposed response to these petitions.

On March 3, 2000, the U.S. Court of Appeals for the District Of Columbia Circuit issued a decision largely upholding the NOx SIP call. EPA is analyzing the effects of that decision.

The EPA did not await a judicial decision on the NOx SIP call because, under section 126 of the Clean Air Act, the petitioning States had the right to a decision from EPA. Thus, regardless of pending litigation on the NOx SIP call, EPA had a statutory obligation to take timely action on the section 126 petitions and the Agency has acted accordingly. Also note that on October 29, 1999, the D.C. Circuit Court of Appeals denied a motion for a stay of the section 126 rule pending resolution of the NOx SIP call litigation. EPA discussed the relationship between the NOx SIP call and the section 126 rule in detail in the December 17, 1999 final rule and response to comments document.

Question 4A. What is your rulemaking schedule regarding the NSR modification rule?

Response. Over the last year, we have been holding extensive meetings with various stakeholder groups working on NSR reform. Additional meetings with these groups are scheduled. We will evaluate all of the input and make a decision on whether we should proceed to issue final decisions on some parts of NSR Reform and potentially to propose for comment other changes to NSR. If we decide to proceed this way, the earliest that these final and proposed decisions would be published would be in Spring 2000.

Question 4B. Where do you stand in the stakeholder consultation process?

Response. Consultation with stakeholders is ongoing. In addition to the public comment period and public hearing associated with the NSR Reform proposal, EPA has had ongoing meetings with stakeholders. For example, a large meeting was held in February 1999 to discuss new ideas from stakeholders, and followup meetings have been occurring regularly since then. Most recently, over the last 3 months, EPA has been having, on average, three or four meetings each month with stakeholder groups, including State agencies, environmental groups, and several different industry groups. Additional meetings are scheduled.

EPA has conducted a longstanding dialog with external stakeholders on the new source review program. Under the auspices of a Clean Air Act Advisory Committee (CAAAC) subcommittee dedicated to this subject, as well as through less formal means, there have been dozens of opportunities for exchanges of views. These discussions have been productive in helping the Agency develop approaches that can provide additional flexibility for affected industries while continuing to protect the environment.

Question 4C. Do you plan to make any revisions to the proposed rule based on those consultations?

Response. The EPA continues to evaluate the issues raised by the NSR Reform proposal, and intends to consider all comments made during stakeholder meetings and during the public comment period. We expect the final NSR Reform rule to differ from the proposal based on comments received, but have not yet finalized our decisions on all the issues raised.

Question 4D. Do you believe that any project that improves productivity requires an NSR permit?

Response. Whether or not projects require NSR permits depends on whether they are non-exempt changes that increase total emissions on a tons per year basis. A project intended to improve productivity will not necessarily increase emissions. However, the ones that do result in significant emissions increases are subject to review.

RESPONSES BY ROBERT PERCIASEPE TO ADDITIONAL QUESTIONS FROM SENATOR MOYNIHAN

Question 1. Please comment on the current sulfur dioxide cap and trade program and whether you believe it could serve as a template for a program targeted at nitrogen oxides.

Response. The current Acid Rain sulfur dioxide cap and trade program has been highly successful. The economic incentives created to encourage emission reductions have resulted in significant, low cost, early reductions resulting in benefits to health and the environment.

For the first time under the Clean Air Act, in 1994, EPA began collecting actual hourly emissions data (SO_2, NOx, CO_2) from large power generating sources through

Continuous Emissions Monitoring systems (CEMs). There has been 100 percent compliance with the SO_2 emissions reduction requirements for this section of the Clean Air Act. Beginning in 1995, there have been significant, cost-effective SO_2 reductions. Utility SO_2 emissions have dropped by over 4 million tons annually relative to the 1980 baseline. The first 4 years of the program have produced SO_2 reductions beyond the legal limit in almost every affected State, with major reductions in the highest emitting areas (Midwest). Full implementation will achieve a 10 million ton reduction from utility and industrial sources, approximately 40 percent below 1980 levels.

During Phase I of the SO_2 allowance trading program (1995–1999), allowance market activity steadily increased both between and within private organizations. The annual cost of complying with the Acid Rain Program, originally estimated by EPA at more than $4 billion, is now estimated at approximately $2 billion upon full implementation (EPA's Section 812 study of Clean Air Act costs and benefits, published in November 1999). The estimate has changed because more utilities than expected have utilized coal switching, because both coal switching and SO_2 scrubbing have proved less expensive than expected for multiple reasons, and because the trading system has proven to be efficient and accepted by the utility industry.

Such impressive results achieved under this program have resulted in expressed interest in cap and trade as a successful model for implementing other pollutant reduction programs. A similar, ongoing program modeled on the SO_2 program already provides a template for a program targeted at nitrogen oxides. The Ozone Transport Commission (OTC), composed of 12 Northeastern States and the District of Columbia, is implementing a cap and trade program to reduce summertime nitrogen oxide (NOx) emissions during the ozone season. EPA has accepted the request of the OTC to administer the NOx cap and trade program, using the SO_2 cap and trade program as a model. Preliminary results from 1999 (the first summer of operation) indicate that the NOx Budget Program is achieving its goal of reducing ozone season NOx emissions. There has been a 55 percent reduction since 1990 by the eight States currently participating in the program. When the program is fully implemented in 2003, summertime NOx emissions in the Northeast will be reduced by 70 percent (from 1990 levels), which is expected to result in lower ozone levels and improved health for Northeast residents.

The OTC NOx Program demonstrates that emissions cap and trading mechanisms can achieve significant NOx emission reductions and improve air quality in the United States at a lower cost than traditional command and control approaches. Emissions were reduced 20 percent below required levels and NOx allowance costs are well below early estimates.

In fact, the acid rain and OTC programs have proven so successful that we developed a cap and trade program to implement the regional NOx reductions called for under the 22-State NOx SIP call rule and the section 126 regional NOx rule.

Question 2. On October 14, New York Governor George Pataki announced a plan to significantly reduce emissions of sulfur dioxide and nitrogen oxides from utilities in New York State. What effect will this proposal have in New York? Do you think it will have any implications in other States? Do you think it will have any effect on initiatives to mitigate interstate air pollution?

Response. New York State's proposed emissions restrictions will lead to lower emissions and will likely improve air and environmental quality in New York and in areas downwind of New York , the implications of which depend on the approach taken by New York. If New York develops a cap and trade program, the additional reductions likely will be achieved more cost effectively than through a command and control approach. The smaller trading market of sources in New York only will likely lead to fewer trading and cost saving opportunities for New York utilities. However, if the health and environmental benefits can be achieved cost-effectively, other States may consider implementing similar programs to reduce pollution in their States, as well as to mitigate interstate air pollution.

RESPONSES BY ROBERT PERCIASEPE TO ADDITIONAL QUESTIONS FROM SENATOR LIEBERMAN

Question 1. Could you describe briefly how EPA considers costs and benefits in setting and implementing air quality standards?

Response. For three decades through 6 different Administrations and 15 Congresses this nation has adhered to the principle that air quality standards should protect public health, including the health of sensitive populations like asthmatics, the elderly, and people with heart and lung disease. We continue to believe that our national air quality standards represent the goals we are striving to achieve, and

a benchmark for citizens interested in whether their air is safe to breathe. Under the Clean Air Act, costs are not considered in setting these health-based standards. (See response to question 6 from Senator Baucus for a fuller discussion of this point.)

However, costs are—and should be—a central consideration as State and local air agencies, EPA and Congress determine control strategies and the length of time areas have to meet air quality standards. The Clean Air Act generally provides more time for highly polluted areas to attain air quality standards, and less time for less polluted areas to attain. For example, Los Angeles—which has generally had the worst ground-level ozone problem in the country—is provided with more time to achieve the standards than areas with less severe ozone problems. This provides time to develop less costly technologies and strategies to reduce air pollution, and to implement them. States consider costs in deciding the control requirements to include in State Implementation Plans. EPA considers costs in developing emissions control rules and guidance at the Federal level. For example, in developing guidelines for States on "reasonably available control technology"—required by the act for certain sources in nonattainment areas—EPA considers costs in determining what is "reasonably available." (See response to question #2.B. from Senator Lieberman for more on consideration of costs.)

Question 2. In order to clarify the extent to which the scientific peer review is incorporated into the agency's rulemaking and standard-setting procedures, it would be helpful to use an example of rulemaking, such as the revision of the NAAQS or the Tier II tailpipe standards, to illustrate the process.

A. Please provide a chart detailing the extent and timing of scientific input, dialog, and peer review for setting air quality standards.

Response. The attached chart lays out the process for EPA's review of the NAAQS, beginning with the publication of scientific studies in peer-reviewed journals through the public comment period and concluding with EPA's publication of its final decision. All studies on which EPA relies are first published in peer-reviewed journals. (E.g., EPA reviewed thousands of peer-reviewed studies when revising the ozone standard.)

EPA then prepares a "criteria document" that identifies and synthesizes the relevant studies. Each draft chapter of the document undergoes further external peer review—it is reviewed by representatives of the scientific community, industry, public interest groups, and the public as well as the Clean Air Scientific Advisory Committee (CASAC), a Congressionally mandated group of independent scientific and technical experts.

EPA revises the criteria document in light of the comments received and, as appropriate, seeks further CASAC and public review to assure that the document represents a comprehensive and accurate summary of the most recent available science.

EPA also prepares a "staff paper" that makes policy recommendations about the standards based on the criteria document. The staff paper is then subjected to a similar round of public and CASAC scientific peer review.

EPA then goes through an extensive public notice and comment process before making any decisions to retain or revise an ambient air quality standard and provides CASAC an opportunity to review EPA's proposed decisions before making final decisions. During the last revision of the NAAQS, CASAC held a series of public meetings over 3 years.

It should be noted that one additional opportunity for scientific review not shown on this chart is provided at the time EPA publishes its proposed decision in the Federal Register, when the Clean Air Scientific Advisory Committee is provided with a copy of EPA's proposal for review. In past reviews, CASAC has typically declined the opportunity to conduct a formal review at this stage.

Question 2B. Please provide the same type of chart detailing how cost considerations are brought into agency considerations of implementation of a regulation, whether through the SBREFA process, industry consultation, or other agency analysis.

Response. Cost is a key consideration as States, EPA and Congress consider strategies for achieving national ambient air quality standards (NAAQS). This factor helps determine which pollution sources should reduce emissions, by how much, and on what timetable.

This question focuses on how EPA considers cost in Federal rules requiring pollution sources to reduce emissions, which complement State strategies for attaining air quality standards. Attached is a chart providing a general overview of the cost analysis process for EPA rules. These cost analyses range from general assessments of cost effectiveness and impacts of a draft rule, to more specific analyses of whether

rules would create unfunded mandates for State and local governments, or have substantial small business impacts.

The Agency consults with stakeholders to develop rules that reduce air pollution at reasonable cost. EPA spends extensive time and effort to involve various stakeholders through its Clean Air Act Advisory Committee, public meetings, regulatory negotiations, stakeholder groups under the Regulatory Flexibility Act (as amended by the Small Business Regulatory Enforcement Fairness Act or SBREFA), and informal meetings and discussions. EPA often voluntarily conducts outreach to small business and other industry groups on cost and other rulemaking issues.

In the case of the Tier 2 rule requiring cleaner vehicles and low sulfur in gasoline to enable effective vehicle emission controls, EPA conducted the cost analyses referenced in the attached chart—and also conducted a special statutorily required study prior to the rulemaking on several issues including cost. The Clean Air Act required EPA to study "whether or not further reductions in emissions from light-duty vehicles and light-duty trucks should be required" beginning between the 2004 and 2006 model years. Specifically, the study and subsequent rulemaking examined:

- the need for further reductions in emissions in order to attain or maintain the national ambient air quality standards
- the availability of technology to meet more stringent standards, taking cost, lead time, safety, and energy impacts into consideration the need for, and cost effectiveness of, such standards, including consideration of alternative methods of attaining or maintaining the national ambient air quality standards.

Throughout the assessment of the Tier 2 program, extensive cost analyses were conducted and provided to the public for review and comment. For the vehicle program, for example, EPA developed information based on discussions with automakers, emission control manufacturers, in-house testing and research, and the California Air Resources Board. That information was utilized to develop detailed manufacturer costs for each vehicle class, including: increases in emission control hardware costs (detailed sub-analyses); assembly costs; research and development; tooling; certification; markup (overhead/profit); and projected short- and long-term cost trends.

EPA promulgated the Tier 2 standards on December 21, 1999, based on criteria laid out in the Act. Cost analyses for the final rule showed, for example, that:

- the annual benefits of the program when fully phased-in far exceed the costs
- the Tier 2 vehicle standards and low sulfur gasoline is a cost effective program

Based on consultation with stakeholders, EPA included flexible compliance provisions in the rule that will reduce the overall cost of compliance to regulated parties. These provisions include averaging, banking and trading; phase-in of vehicle standards; regional phase-in of low sulfur gasoline; and, hardship provisions for qualifying refiners, including a phase-in of the standards for small refiners based on information developed during the SBREFA process.

It is important to note that States have principal responsibility under the Clean Air Act for developing strategies to achieve the national ambient air quality standards (NAAQS). The Act provides substantial flexibility in the States' development of implementation plans to consider costs and mitigate potential impacts on businesses. The Act requires that cost considerations be included in determining levels of control required by the Act such as "reasonably available control technology" (RACT) and "best available control technology" (BACT), and this is reflected in EPA guidance to States. Additional opportunities for mitigating impacts on businesses include phase-in of controls on existing sources, use of regional control strategies, and use of flexible strategies such as emissions trading and other economic incentives. The Act and EPA guidance provide for use of trading and economic incentive strategies.

The Act allows significant time to identify and implement cost effective strategies for attaining the NAAQS. For certain NAAQS, Congress in the 1990 amendments categorized areas according to the severity of pollution, and provided the more polluted areas with more time to attain. For other NAAQS, the Act can provide up to 12 years for areas designated nonattainment to attain. Since at least 2 years generally elapse before areas are designated nonattainment and longer in the case of the 1997 ozone and PM NAAQS revisions due to the need to gather than analyze air quality data the Act provides States with substantial time for development of cost effective attainment strategies.

In developing guidance for States on implementation of air quality standards, EPA has consulted heavily with representatives of private industry, the environmental community and State, local and other Federal agencies For example, in the case of the 1997 ozone and particulate matter NAAQS, EPA convened an advisory committee under the provisions of the Federal Advisory Committee Act which ad-

vised EPA over a 2-year period. EPA also consulted with small business representatives to obtain recommendations on how States could mitigate adverse impacts on small businesses as they develop and implement their State Implementation Plans.

Question 3. Some confusion emerged during the hearing regarding my statement that the dramatic increases in asthma cases among children has made them more vulnerable to smog pollution. Am I correct in understanding that while the cause of asthma is not attributed to a single pollutant, smog and soot can exacerbate their health problems?

Response. You are correct. Available scientific information does not currently demonstrate that air pollution actually causes asthma, but numerous scientific and medical studies have shown an association between high pollution levels and increased hospital admissions for treatment of asthma and other respiratory illnesses. There is concern that repeated exposures and responses to air pollution adversely affects people with asthma and respiratory illnesses, requiring increased use of medication, medical treatment, and/or emergency room visits and hospitalization. This is of special concern in light of the growing number of people with asthma, particularly children.

Question 4. Some suggested that we should look more closely at the problem of indoor air pollution as a cause of asthma and other health problems. What current statutory authority does EPA have to regulate indoor air? Would the agency be willing to provide recommendations to Congress on how to establish authority to reduce pollution from indoor sources?

Response. EPA does not currently have statutory authority to regulate indoor air. Under Title IV of the Superfund Amendments and Reauthorization Act of 1986, the "Radon Gas and Indoor Air Quality Research Act of 1986," EPA is authorized to establish a research program with respect to indoor air quality, demonstrate methods for reducing or eliminating indoor air pollution, and disseminate information to assure the public availability of any findings.

The Agency is willing to work with the committee to review the Clean Air Act and indoor air issues. As we go through the hearing process with the Committee, we will have a better feel for whether reopening the Act would be more beneficial or disruptive on the whole. One topic that would be worth evaluating as part of the hearing process is whether EPA should be given additional authority to encourage States and industry to take actions that reduce risks from indoor air pollution.

Question 5. Numerous allegations about the relationship between job loss in nonattainment areas were made during the hearings. Is it true that the number of jobs in nonattainment areas is declining?

Response. In fact, the number of jobs in non-attainment areas has been increasing. There were 294 counties in non-attainment status in 1997. From 1990 to 1997, the number of jobs in these counties increased by more than 5.8 million, from 66.8 million to 72.6 million. Data are from the Regional Economic Information System produced by the Bureau of Economic Analysis, U.S. Department of Commerce.

Question 6. Are there reasons that cost considerations should be treated differently in setting and implementing standards under the Clean Air Act than under the Safe Drinking Water Act?

Response. There are important similarities in the way that costs are considered under the Safe Drinking Water Act (SDWA) and the Clean Air Act. First, both laws establish health-based goals . Second, under both Acts, costs are considered at the implementation stage, when control requirements for an industry are being established .

As your question indicates, there are differences as well as similarities in standard-setting under the two statutes. Under the Clean Air Act, EPA develops national ambient air quality standards to protect public health, without consideration of costs. Costs and benefits are considered (by States, EPA, and in some cases, Congress) in determining which pollution sources should reduce emissions, and how quickly the reductions must be achieved.

Under the drinking water act, EPA establishes health protection goals for drinking water quality without regard to cost, and then sets regulatory standards for public water systems, considering costs and technological availability. The 1996 SDWA amendments expanded the existing authority to consider costs in setting these regulatory standards by requiring EPA to develop a health risk reduction and cost analysis and by giving EPA conditional discretion, based on the analysis, to set a regulatory standard that maximizes health risk reduction benefits at a cost that is justified by the benefits.

Differences in the two laws stem from differences in the tasks of reducing air pollution and cleaning up drinking water:

A drinking water standard establishes the requirements for a particular industry (public water systems). By contrast, under the Clean Air Act, requirements for particular industries or sources are established after the air quality standard is set, providing considerable opportunity to consider costs at this second stage.

Setting an air quality standard triggers an implementation process in which choices must be made concerning which types of pollution sources should reduce emissions, in which areas, to what degree, by what deadline. This process includes, for example, development of enforceable State Implementation Plans and national rules such as motor vehicle standards. Costs are a central factor in determining reasonable emission reduction requirements.

Estimates of the cost of achieving a national ambient air quality standard are subject to much more uncertainty than estimates of the cost of meeting a drinking water standard, for several reasons.

Standards for drinking water quality constitute specific, technology-based requirements for one industry—public water systems. There are identified types of facilities and corresponding technologies that serve as benchmarks that engineers use to calculate costs of those requirements. So cost estimates are based on a known set of requirements for one industry.

By contrast, when EPA sets a National Ambient Air Quality Standard, it is unclear at that time which sources will be regulated and/or to what degree they may be regulated, and over what geographic area. There is a large universe of pollution sources and potential emission reduction strategies. So although cost estimates for NAAQS can be developed, they are subject to additional categories of uncertainty not involved with cost estimates for drinking water standards: (1) uncertainties regarding which types of pollution sources will be regulated, in which geographic areas, (2) uncertainties regarding the nature and stringency of requirements to be set for those sources, (3) the additional uncertainty resulting from conducting cost estimates for numerous industries, rather than for one industry, (4) uncertainty arising from the modeling of complex atmospheric chemistry and meteorology to estimate effects of precursor emission reductions on ambient levels of a NAAQS pollutant. As a result, uncertainties regarding the cost of achieving a NAAQS typically are much greater than those regarding the cost of meeting a drinking water standard.

In addition, most drinking water standards are required to be achieved within a relatively short time period, typically from three to 5 years. By contrast, Congress has provided longer time periods (in the case of the 1-hour ozone standard, up to 20 years, depending on the severity of an area's pollution) for the Nation as a whole to attain air quality standards. As a result, technology advances can reduce costs and make it possible to achieve reductions that were once thought infeasible. The history of the Clean Air Act provides many examples of this phenomenon (see response to question #2 from Senator Baucus). This technology innovation factor further adds to the uncertainty of estimating the cost of achieving a NAAQS.

To recap, both laws establish health-based goals, and then consider costs at the implementation stage, when control requirements for an industry are being established.

RESPONSES BY ROBERT PERCIASEPE TO ADDITIONAL QUESTIONS SUBMITTED BY SENATOR BAUCUS

Question 1. Did EPA or other Federal agencies cutoff the distribution or allocation of acid rain allowances prematurely or provide them on a first come/first served basis? Please comment on the distribution process.

Response. All of the SO_2 allowances were distributed by EPA as authorized by the Clean Air Act. The vast majority (about 90 percent) of the Phase I allowances either were distributed to the sources listed in Table A of section 404 of the Act or were allocated according to the formulas provided in section 404. The rest were distributed through an auction authorized by section 416 of the Act. Except for the auction, Phase II allowances were allocated to all eligible units according to the formulas provided in section 405 of the Act and then, as required by the Act, were decreased (approximately 10 percent) to achieve the 8.95 million ton emissions cap.

Your question concerning "premature" or "first-come, first served" allowance allocations seems to refer to the allocation of allowances in the Phase I Extension Reserve. This reserve, which represented a small portion (about 10 percent) of total Phase I allowance allocations was distributed on a first-come, first-served basis, again according to the statute. Section 404 of the Act provided that designated representatives who commit to install technologies achieving 90 percent reduction of units' SO_2 emissions could request a 2-year extension of the deadline for meeting

Phase I emission reduction requirements by applying for additional allowances from a special allowance reserve. Section 404 required EPA to process extension requests "in order of receipt". Since the reserve might be oversubscribed, EPA determined, after taking public comment, that distributing the Phase I extension allowances using a lottery system was consistent with the statutory language and the least burdensome and most expeditious method for ranking Phase I extension applications. The full amount of reserve allowances was distributed, according to a lottery system, to the eligible units. However, some utilities preferred a pro rata method of distribution because they were concerned that they might not be awarded any allowances in the lottery. These utilities entered into and implemented a private agreement under which the allowances awarded through the lottery were re-distributed to all eligible units on a pro rata basis.

The Clean Air Act provided for some other special reserves of allowances, e.g., for conservation and renewable energy and for small diesel refiners. These reserves contained enough allowances for all eligible participants to receive the full amount of allowances to which they were entitled under the Act.

Question 2. How does EPA estimate the ability of the regulated community to innovate and thereby meet more stringent standards?

Response. EPA works closely with regulated communities to obtain information on currently available technologies and their estimated costs, and on emerging technologies. Nonetheless, as is the case for technology generally, air pollution control technology is developing so rapidly that it is difficult to predict very far into the future. Over short time horizons for a particular industry, however, it is possible to make some educated judgments regarding feasibility and likely cost of emerging technologies.

Regarding air quality standards, we know based on experience that technological advances over the longer term will provide substantial help in meeting our clean air goals. But it is inherently difficult to estimate the amount of emissions reductions and cost savings that will be provided five, 10 or 15 years from now by technological advances in numerous industries—including advances that are entirely unforeseen today.

Our experience over the past 30 years, and the promise of cleaner technologies emerging today, strongly suggest that technological innovation will continue to produce new, cleaner processes and performance improvements that reduce air pollution at reasonable cost. The Clean Air Act has helped lead to technology innovation and performance improvements. Over and over again, innovative companies have responded to the challenges of the Act with great success, producing breakthroughs such as alternatives to ozone-depleting chemicals and new super-performing catalysts for automobile emissions.

Technological innovation has enabled the regulated community to achieve emissions reductions some critics had thought simply infeasible, and to reduce anticipated compliance costs. Two examples of this phenomenon are the Tier I tailpipe standards for cars and light-duty trucks, and the phaseout of CFCs. (See written testimony by Assistant Administrator Bob Perciasepe.) Another example in which technological advances have reduced costs is sulfur dioxide scrubbers for power plant emissions. Scrubber efficiency has improved from average reductions of around 80 percent in the early 1980's to over 90 percent reduction in the 1990's while capital costs decreased substantially.

There are many examples of technologies that were not commercially available in the United States a dozen years ago, but that now are important parts of pollution control programs. These include:

- Selective Catalytic Reduction (SCR) for NOx emissions from coal-fired power plants;
- Fuel lean or advanced gas reburn technology for NOx;
- Scrubbers which achieve 95 percent SO_2 control on utility boilers (available but not achieved by utilities in the United States a dozen years ago);
- Sophisticated new valve seals and detection equipment to control leaks;
- Water and powder-based coatings to replace petroleum-based formulations;
- Reformulated gasoline;
- LEVs (Low-Emitting Vehicles) that are far cleaner than had been believed possible in the late 1980's (an additional 95 percent reduction over the 1975 controls);
- Reformulated lower VOC paints and consumer products;
- Safer, cleaner burning, wood stoves;
- Dry cleaning equipment which recycles perchlorethylene; and
- CFC-free air conditioners, refrigerators and solvents.

This pattern of technological progress is continuing today. In the regulatory impact statement for the 1997 ozone and PM NAAQS, EPA identified a number of

emerging technologies—ranging from fuel cells to ozone-destroying catalysts to new coating technologies—that may hold promise for achieving additional cost effective reductions of VOC, NOx and particulate matter. Similarly, the University of California-Riverside's Center for Environmental Research & Technology has identified a long list of new and emerging technologies that may help achieve cleaner air in the 21st century (see attached document).

Based on this, EPA believes it is clear that technological advances will continue to help us make progress toward healthful air. We can continue to promote innovation by maintaining air quality standards stringent enough to protect health, thereby challenging the Nation to continue to develop new cleaner technologies. In addition, we can promote emission reduction strategies that provide flexibility on the means of reducing emissions (e.g., market-based strategies) to allow use of innovative emission reduction methods.

Question 3. Please provide some more examples, relative to The Clean Air Act Amendments of 1990, of the costs of compliance estimated by the regulated community prior to passage of that Act versus the actual costs experienced today.

Response. My written testimony provided five examples in which the regulated community (1) over-estimated costs of the 1990 amendments, or (2) incorrectly predicted that proposed requirements were simply infeasible. The cost examples involved the overall cost of the 1990 amendments, the cost of the acid rain program, and the price of reformulated gasoline. The feasibility examples involved the CFC phaseout and the Tier I auto tailpipe standards.

EPA anticipates being able to provide you with more examples in the near future.

Question 4. A utility witness suggested that EPA is in a "mad rush" to have NOx SIP Call controls in place by 2003. How long has it been recognized that regional NOx reductions would be necessary to address ozone transport problems? How long has EPA been discussing regional NOx controls with States and the utility industry?

Response. Since the late 1980's it has been recognized that regional NOx reductions are necessary to address ozone transport problems. EPA and States have been working for years to determine how best to reduce smog-causing emissions from power plants and other sources, and have been discussing regional NOx controls with utilities for nearly a decade, beginning in the northeastern States.

The provision in the 1990 Clean Air Act Amendments establishing the Ozone Transport Commission explicitly recognizes the issue of ozone transport. Furthermore, in 1991, the National Academy of Sciences issued a report ("Rethinking the Ozone Problem in Urban and Regional Areas") that stated that in many parts of the country controlling NOx emissions would be necessary to reduce ozone. Since 1993, States have been expressing concern to EPA that emissions from "upwind" areas need to be addressed so that the States can meet the Clean Air Act's requirements for demonstrating attainment. After lengthy analysis and discussions, the 12 Northeast States and the District of Columbia, which participate in the Ozone Transport Commission, signed an agreement in 1994 that established a phased program leading to substantial NOx controls on major sources in that region.

In May 1995, EPA, the 37 States in the eastern half of the United States, and other stakeholders, including utility and environmental representatives, convened the Ozone Transport Assessment Group (OTAG) to analyze regional ozone transport in the East. This group modeled and analyzed ozone pollution in the East for 2 years. In June, 1997, OTAG concluded that ozone is transported and that regional NOx reductions are effective in producing ozone benefits. OTAG recommended a range of utility and non-utility NOx control levels to address the ozone transport phenomenon. EPA proposed the NOx SIP call for regional NOx reductions in October 1997 , and continued to discuss regional NOx controls with States and the utility industry throughout the rulemaking process and following issuance of the final rule in September 1998.

EPA's NOx SIP Call allowed almost 5 years from the 1998 date for compliance with emission reduction requirements. The NOx SIP requires compliance by May 1, 2003, providing 55 months between finalizing the rule and the compliance deadline. EPA evaluated the technical and economic feasibility of installing sufficient pollution controls to achieve the emissions reductions required by the NOx SIP call and concluded that even with multiple installations of SCR and SNCR at the same plant, the longest it would take to install all needed controls would be 34 months. Even if States took the full 12 months allowed to complete their SIPs, sources would have 43 months to comply.

EPA also examined the impact on power plant availability and thus electric reliability. The Agency concluded that outages would be of short duration and could take place during the Spring and Fall seasons when electric demand is lower, and that these outages would not cause reliability problems. In addition, recent experi-

ence installing SCR has suggested shorter installation times than EPA used in its analysis and, therefore, the Agency believes that the analysis upon which the rule was based is conservative.

EPA also provided a "compliance supplement pool" of NOx emission reduction credits that States could allocate to sources who, in good faith, needed more time to achieve compliance with the control requirements. This pool of credits would enable the industry to delay up to one-third of the control technology installations if unforeseen problems should occur in obtaining and installing control equipment.

On March 3, 2000, the U.S. Court of Appeals for the District Of Columbia Circuit issued a decision largely upholding the NOx SIP call. EPA is analyzing the effects of that decision.

Question 5. Although strong enforcement is one component of making sure we achieve our air quality goals, there are a lot of good corporate citizens that want to comply with their environmental obligations, but can't always determine what they are supposed to do. Please describe EPA's efforts to help small businesses and others comply with the Act.

Response.

Office of Air and Radiation Activities

The CAA required States to develop a Small Business Stationary Source Technical and Environmental Compliance Assistance Program to aid small businesses impacted by air regulations. This program:

- Is funded by permit fees;
- Directly reaches more than 1,000,000 small businesses a year through: toll-free hotlines; fact sheets; brochures; seminars and meetings; websites; and
- Has resulted in more than 14,000 onsite consultations conducted each year.

The EPA provides information and support to the State Small Business Assistance Programs to assist in their compliance assistance activities; small businesses can also access this information directly through:

- the EPA Small Business Assistance Program website, which includes: State and EPA contact listings; Small business materials and programs developed by States and EPA; Links to other EPA and State sites; "Plain-English" guidance materials to explain new air regulations, such as guidebooks on the standards for architectural coatings and wood furniture manufacturing.
- Satellite downlink seminars to educate small businesses on new air regulations (five industry-specific seminars have been held since 1994 reaching an average of approximately 2,000 participants each).

Office of Enforcement and Compliance Assurance (OECA) Activities

EPA reorganized its enforcement and compliance programs in June 1994. This reorganization was based on the principle that EPA needed to complement its enforcement program with innovative new tools to better protect public health and the environment by improving compliance with environmental laws. OECA continues to develop new approaches to compliance assistance and incentives policies.

EPA is committed to broadening its compliance assistance programs as a result of a recent mid-course review of our program. As stated in its recently released "Action Plan for Innovation," EPA is committed to expanding the use of integrated strategies that combine compliance assistance, compliance incentives, compliance monitoring, and enforcement activities. EPA's experience has shown that this approach can be very effective in addressing significant environmental risks.

Compliance Assistance

EPA's compliance assistance program—a complement to EPA's strong base enforcement program—is directed toward the special needs of small businesses, small communities, and local governments. In fiscal year 1999, compliance assistance activities and tools—seminars, onsite assistance, mailings, and handouts—reached approximately 330,000 entities.

Compliance Assistance Centers—Four new "on line" National Compliance Assistance Centers were opened for the paints and coatings, transportation, and small and medium sized chemical manufacturing sectors, and local governments, bringing the total number to nine centers in operation by the end of fiscal year 1999. These Internet-based centers provide compliance information and pollution prevention techniques for certain industry sectors, such as paints and coatings, metal finishers, and automotive. Currently the centers are being visited over 700 times a day.

Preliminary results from a survey of users of OECA's GreenLink Compliance Assistance Center, a web-based center for auto shops, show that compliance improves when facilities are given assistance. The results show that over a 2-year period, the number of facilities in substantial compliance jumped from 25 percent to 51 percent.

Sector Notebooks—EPA to date has developed 30 sector notebooks for major industries. These sector notebooks provide information on the regulatory requirements and pollution prevention approaches needed to maintain and enhance compliance. To date over 450,000 notebooks have been distributed, and they remain one of OECA's most popular products.

Regional Compliance Assistance Activities—All regions have compliance assistance activities and identified national priority areas. In addition, EPA's regions work with States to identify other regional or State-specific compliance assistance priorities.

Region I Compliance Assistance for Printers: In Region One, printing continued to be a compliance assistance priority. A Fit To Print guide was sent to over 1400 printers throughout the Region. Of those who responded to an evaluation of the guide, 70 percent said that they had undertaken "improved environmental practices" such as equipment changes/modifications, material substitution, recycling, training, institution of environmental management policies or procedures, and improved disposal methods as a result of compliance assistance efforts. These facilities also said that they took action to apply for appropriate permits or identification numbers, or file reports as necessary to comply with Federal, State or local environmental regulations.

Region Two Outreach Efforts to Dry Cleaners: EPA's Region II office, in coordination with New York State agencies, has focused compliance assistance efforts on dry cleaners in New York and New Jersey. Their outreach efforts included onsite visits and the distribution of easy-to-understand guides to Clean Air Act requirements. In addition, the Region developed a web site for compliance assistance information and held 8 seminars on equipment maintenance and new technologies for approximately 500 owners/ operators. This effort has resulted in a reduction of 11.9 tons of PCE from urban air.

Compliance Incentives

Recognizing that effective incentives promote compliance, EPA has worked with State and local partners and small business groups over the past several years to develop policies with real incentives for industry and others to voluntarily identify and correct their own environmental violations. The Agency relies on a wide array of traditional and innovative compliance incentives tools, such as EPA's Audit Policy, to encourage companies that want to do the right thing by discovering and disclosing their violations.

Self-Disclosure (Audit) Policy—EPA's Audit Policy establishes a system under which companies who discover environmental violations through a self-auditing system can receive reduced penalties if certain conditions are met. Since inception of the policy in 1996, approximately 670 companies have disclosed potential violations at over 2700 facilities; approximately 270 companies have been granted penalty relief and corrected violations at over 1300 facilities.

In fiscal year 1999, a record 260 companies had disclosed violations at close to 1000 facilities. EPA settled with 106 companies at 624 facilities, a significant increase over previous years.

A major audit settlement with American Airlines (AMR Corporation) is expected to eliminate nearly 700 tons of air pollutants annually. A settlement with GTE, which involved 600 violations at over 300 facilities, led to ten other telecommunications companies voluntarily disclosing and correcting 1,300 environmental violations at more than 400 facilities.

Seventy-six small businesses disclosed and corrected violations under the provisions of the small business self-disclosure policy, a sevenfold increase from the previous year.

Compliance Audit Programs (CAP)—CAP programs are voluntary compliance programs, focused on a specific industry sector, which provide incentives to facilities to conduct environmental audits. Facilities which conduct an audit, and promptly disclose and correct any violations found, have the opportunity for waived, reduced or capped penalties.

Question 6. In testimony, Professor Graham suggested taking a two-tiered approach to Clean Air Act standards. First, a lenient and flexible cost-benefit analysis, one that does not require high degrees of precision, would be used to set the actual ambient standard. Second, a more stringent cost-benefit analysis would be performed to determine whether or not to apply controls to specific sources. What views, if any, do you have on such an approach?

Response. EPA opposes the two-tier approach suggested by Professor Graham. This approach calls for setting air quality standards based on cost-benefit analysis, rather than on protection of public health. For three decades through 6 different Administrations and 15 Congresses this nation has adhered to the principle that na-

tional air quality standards should protect public health, including the health of sensitive populations like asthmatics, the elderly, and people with heart and lung diseases. This approach recognizes that all Americans deserve to breathe clean air. EPA continues to support this equitable goal.

EPA of course agrees that costs are relevant in considering environmental policy. But costs are not—and should not—be considered in setting public health standards for air quality. Rather, costs are—and should be considered in the implementation of air quality standards, as decisions are made concerning how to reach the health-based goal (E.g., the relative pollution reduction contributions of different sources, in different geographic areas). There is substantial opportunity to consider costs as States, EPA and Congress decide which pollution sources should reduce emissions, by how much, and on what timetable. Moreover, the Act provides impetus for our nation to identify economically acceptable ways to attain clean air, through ingenuity and technology advances. (See responses to Senator Baucus questions #8 and #2.)

Using this approach, the Clean Air Act over the past 30 years has been successful in achieving substantial improvements in air quality while the Nation also enjoyed strong economic growth and enhanced productivity.

Question 7. During the hearing, the utility industry witness indicated that EPA has not been interested in holding a dialog with that industry on coordinating the regulatory requirements facing that industry because independent statutory provisions drive these requirements and EPA cannot coordinate them without a change in law. Please comment.

Response. It would be inaccurate to characterize EPA as being reluctant to hold a dialog with industry on coordinating regulatory requirements with the utility industry. Indeed, EPA initiated and encouraged the industry and others to participate in such discussions 5 years ago. Following consultation with industry and other stakeholders, EPA undertook the development of the Clean Air Power Initiative (CAPI) in 1995. The goal of CAPI was to develop an integrated strategy for achieving the goals of the Clean Air Act with respect to the power generating industry. EPA recognized that there are numerous CAA requirements that affect the power generating industry, and that they involve complex, costly and sometimes uncertain regulatory processes. EPA also recognized the economic uncertainty created by restructuring within the power generation industry. CAPI highlighted the multiple public health and environmental concerns associated with emissions from power generation, including ozone, fine particles, toxics, acidification, eutrophication, visibility/regional haze, and materials damage. CAPI outlined an approach that would translate health and environmental goals into emissions targets, employ a market-based cap and trade mechanism, provide more regulatory certainty, flexibility and cost savings, and serve to coordinate the number of regulatory requirements affecting the industry. At the request of industry participants, analyses undertaken for CAPI focused on SO_2 and NOx and did not include mercury and carbon dioxide. Several implementation paths were considered, such as the current path using separate programs and requirements to address each pollutant and problem, the use of cap-and-trade mechanisms, and the establishment of voluntary incentive programs including early reductions. Industry positions varied among companies, and no common position or consensus was reached.

Recently, in 1998, the EPA was invited by industry representatives to discussions related to an integrated strategy, specifically aimed at integrating new source review (NSR) with other regulatory requirements. EPA and industry shared views of future potential regulatory scenarios and possibilities for integration. The discussions were constructive, and EPA intends to consider these discussions as it evaluates future changes to the NSR program.

Question 8. At the hearing, Professor Graham stated, "I think any careful environmental analysis of what is going on here would indicate that we are having less economic productivity in this country and we are having more air pollution in other countries." Please comment.

Response. We would make two points:

First, EPA believes that economic growth and a clean environment can go hand in hand. From 1970 to 1997, the U.S. Gross Domestic Product (GDP) grew by 114 percent, and population grew 31 percent. Between 1973 and 1995, productivity (non-farm business sector) grew at an annual rate of 1.4 percent. From 1995 through 1999, productivity grew at a much more robust 2.9 percent per year. This economic growth and enhanced productivity occurred while the Nation also enjoyed substantial improvements in air quality. In 1997, national average air quality levels were the best on record for the six air pollutants for which EPA has established national ambient air quality standards (lead, NO_2, SO_2, PM_{10}, CO, and ozone).

While having strong environmental protection programs, the United States is one of the most economically productive countries in the world. A list of the manufacturing output per hour for 14 countries from the Bureau of Labor Statistics compares the economic productivity of the United States relative to other developed countries. The data show that the average output per hour in manufacturing for the United States over the years 1990 to 1998 was 109.8 units of output. The United States was surpassed only by Sweden whose average was 114.5 units of output and the Netherlands with 113.6 units of output. The average annual growth rates of productivity between 1990 and 1998 were also calculated for the 14 countries using the Bureau of Labor Statistics data and they show that U.S. productivity has grown at an average annual rate of 3.34 percent between 1990 and 1998. Sweden, France, and the Netherlands were the only three countries with higher average annual productivity rates for the same time period. Their average annual growth rates were 4.67 percent, 3.98 percent, and 3.85 percent, respectively.

Another commonly relied upon measure of economic growth and productivity is per capita gross domestic product (GDP). A list of the 1997 per capita GDP for 204 countries from the Statistics Division of the United Nations Secretariat and International Labor Office compares the value of goods and services produced by United Statesand other countries. The data show that the United States had the eight highest per capita GDP measure in 1997 at $28,789. Only Luxembourg, Bermuda, Switzerland, Liechtenstein, Norway, Japan, and Denmark had higher 1997 per capita GDP measures.

Second, many countries like the United States have made significant efforts to improve their air quality to protect public health and the environment. For example, a number of European countries between 1980 and 1997 saw large percentage decreases in emissions of sulfur and nitrogen oxides. Of course, it is also true that many countries such as China, India, Thailand, Russia, and Mexico have far worse air quality than the United States. The fact that these countries have these issues is not a reason to have more pollution in the United States; it is a call for us to work with those countries both in terms of their economic well being and their environmental health.

RESPONSES BY ROBERT PERCIASEPE TO ADDITIONAL QUESTIONS FROM SENATOR GRAHAM

Question 1. According to your testimony, air emissions of nitrogen oxides have been increasing. What is causing this trend? What do you believe would be the most effective steps the Federal Government could take to reverse this trend?

Response. Air emissions of nitrogen oxides have increased since 1970 due primarily to 1) increases in emissions from coal-fired power plants and 2) increases in emissions from certain mobile sources, including on-road and non-road diesel engines and light-duty trucks. From 1970 to 1997, U.S. Gross Domestic Product grew by 114 percent, the U. S. population grew by 31 percent, the number of miles traveled by on-road vehicles (VMT) increased by 127 percent, and from 1970 to 1998, electricity production increased by 136 percent. Despite these increases, the Nation recorded decreases in emissions of certain pollutants due to programs implemented under the Clean Air Act. For example, emissions of sulfur dioxides from coal-fired power plants dropped over this time period, as did emissions of volatile organic compounds and nitrogen oxides from passenger vehicles and many other sources. However, the same cannot be said for emissions of nitrogen oxides from power plants, diesel engines and other sources. Awareness of the need to control NOx from power plants and some of these other sources has grown over the past several years.

Emissions of NOx result primarily from fuel combustion at high temperature. Fuel and biomass combustion in mobile and stationary sources accounts for about 95 percent of NOx emissions. As noted below, EPA, in partnership with State and local agencies and other stakeholders, have a number of programs in place as well as new initiatives in progress to decrease NOx emissions. Successful implementation of these Federal activities, together with local, State and regional efforts including measures in local nonattainment plans (e.g. vehicle inspection and maintenance programs), and strategies to reduce regional levels of NOx are cost-effective steps that will lead to important decreases in NOx emissions across the country.

Mobile Sources

Since the 1970's EPA has required motor vehicle manufacturers to decrease significantly emissions of NOx from light duty on-road vehicles. New Tier 1 light duty vehicle requirements were phased-in over the 1994–96 model years. The EPA has continued to work with State officials, auto manufacturers, oil industry and others

to develop even cleaner cars, including the National Low Emission Vehicles program and the recently announced Tier 2/sulfur program. Vehicle miles traveled increased 25 percent nationally during the past 10 years. Despite the increase in vehicle miles traveled, total on-road vehicle emissions have been decreasing and will continue to decline through 2020 as new, Tier 2 cars and light trucks replace older, more polluting cars.

Reduction in NOx emission levels from heavy-duty vehicles is expected from lower tailpipe standards for engines produced after 1991 and further reductions are expected as 1998 and 2004 model year engines meeting tighter emission standards are phased into use. In addition, the Agency will soon propose more stringent emission standards for diesel engines used in large trucks and buses, as well as requirements for low-sulfur diesel fuel. The EPA is also working to implement several non-road programs to decrease NOx emissions from large marine, aircraft, locomotive, and engines used in agriculture, construction, and general industrial equipment.

Stationary Sources

To help control acid deposition, the Clean Air Act established a two phased program to reduce emissions of NOx from coal-fired electric utility generation units. Electric utility NOx emissions are expected to decline as the Phase II acid deposition NOx emission rate limits become effective.

Further reducing utility NOx emissions using a cap-and-trade system is a highly cost effective way to reduce regional NOx emissions. To help cut ground-level ozone levels across the Eastern United States, EPA worked with the States to develop the NOx SIP call rule to further reduce NOx emissions from power plants and/or other sources in 22 eastern States and the District of Columbia. Similar reductions are required in 12 States and the District of Columbia as a result of EPA's recent grant of petitions from eastern States under section 126 of the Clean Air Act.

Continuing to implement these cost-effective programs will reverse the long-term trend of increases in NOx emissions; more NOx was emitted into the air in 1997 than in 1970. To sustain those reductions over time, it may be important to consider programs like those that place a cap or limit on total emissions.

Question 2. Can you elaborate on the changes that you believe should be made to the Clean Air Act?

Response. We are committed to working with Congress to provide a targeted legislative solution that maintains our air quality gains and allows for the reduction of MTBE, while preserving the important role of renewable fuels like ethanol.

On the broader question of reauthorization of the Clean Air Act, we are not currently advocating changes to the Act. I am willing to work with the committee to review the Act and consider where it might benefit from improvements, as I stated during the hearing. As we go through this hearing process together, we will have a better feel for whether reopening the act would be more beneficial or disruptive on the whole.

The following are some ideas that have been raised and would be worth examining during the hearing process, which we understand is to take place over the next couple of years:

Providing clearer authority for EPA to develop and directly implement multi-State solutions, such as cap-and-trade programs, for regional air pollution problems caused by any pollutant.

Providing additional authority for EPA to encourage States and industry to take actions that reduce risks from indoor air pollution. (See response to Sen. Lieberman question #4.)

Question 3. Some have argued that those older fossil fuel power plants that are not required to meet the new source performance standards will continue to operate indefinitely because the exemption in effect, has created an economic advantage. Do you believe emissions of nitrogen oxide would be more effectively and efficiently reduced by phasing out this loophole or by allowing a cap and trade program?

Response. We are willing to discuss approaches to eliminating this "grandfathering" approach with a more effective solution to cap emissions and allow trading. A cap and trade program allows companies to make cost-effective choices on operating their units and installing controls while still complying with the emission reduction requirement.

The cap would ensure that the desired environmental result would be achieved, and trading would allow each facility to pursue the lowest cost approach for its system. When designed and implemented properly, cap and trade programs offer many advantages over traditional command and control counterparts (such as a requirement that all power plants meet a specific performance standard) including (1) reduced cost of compliance, (2) creation of incentives for early reductions, (3) creation of incentives for emissions reductions beyond those required by regulations, (4) pro-

motion of innovation, and (5) increased flexibility. A market system that employs a fixed tonnage limitation for a group of sources provides great certainty that a specified level of emissions will be attained and maintained since a predetermined level of reductions is ensured. A cap and trade program is a highly effective approach for ensuring that industry has the flexibility to grow while still managing the emissions impact of growth. With respect to transport of pollution, an emissions cap also provides the greatest assurance to downwind States that emissions from upwind States will be effectively managed over time.

STATEMENT OF ALLISON KERESTER, MICKEY LELAND NATIONAL URBAN AIR TOXICS RESEARCH CENTER

Introduction

The Mickey Leland National Urban Air Toxics Research Center (Leland Center) was established by Congress under Title III, Section 301(p) of the 1990 Clean Air Act Amendments. Congress created the Leland Center as a non-profit, public/private research organization to sponsor research on the potential human health impacts of the 188 listed air toxics. The Leland Center is governed by a nine-member Board of Directors, appointed by Congress and the President. A thirteen-member Scientific Advisory Panel, composed of nationally recognized scientists and physicians, establishes the Leland Center's peer-reviewed research program. The Leland Center's mission is to contribute meaningful and relevant data to the scientific literature on the potential human health effects of air toxics. We view this contribution as a fundamental component in the national effort to develop cost-effective and balanced regulations to protect the public health from the potential risks of air toxics.

After exploring the most critical public health aspects of air toxics risks, the Leland Center's Board of Directors identified two fundamental research data gaps: (1) the determination of the actual human exposures to air toxics in urban environments, and (2) the non-cancer health effects of such exposures. The Leland Center chose to pursue personal exposure research. We were the first research institution to develop a research program on personal exposures to air toxics in urban populations.

Exposure

Traditionally, ambient air concentrations of air toxics have been equated with adverse health effects. Under this approach, the larger the airborne concentration, the larger the potential human health risk. However, it is actual exposure, and not air concentrations, that is the critical component needed to determine potential adverse health effects from a pollutant emission into the environment. High airborne concentrations of air pollutants in an area without people means there is no exposure. Without exposure there is no human health risk.

In its March 1998 report Research Priorities for Airborne Particulate Matter-Volume I, the National Research Council states that the relationship among outdoor, indoor, and personal exposure is a fundamental factor in determining potential human health effects. Exposure is one of the two major elements (the other being the determination of the most biologically active constituents (of a pollutant or particle) on which other research, such as epidemiological studies, should be based. The National Research Council named exposure research as one of the 10 most critical research areas. Only with exposure information can the potential public health impacts be calculated.

Exposure Defined

Exposure is the contact of a chemical, biological or physical agent at the boundary of the body over a specified time period. People are exposed to chemicals through inhalation, ingested through food or absorbed through the skin. People are exposed to air pollutants primarily through inhalation. However, deposition onto soil, food, and water, can result in other exposure routes. Actual human exposure is a function of outdoor sources, indoor sources, and human activity patterns. (NRC, 1998). Thus, what people are actually exposed to is a result of where they spend their time and what air pollutants are present in those areas. People do not spend their time in just one location, but rather move through a series of locations (or microenvironments) such as the home, car, office, outside, throughout the day.

Exposure Assessment

Exposure assessment is the science of determining what people are exposed to and how they come into contact with various contaminants. Exposures can be estimated by a number of methods. See Attachment 1. The most accurate measurements are obtained by measuring people directly, such as through the use of personal mon-

itors, breath, urine, and blood samples. Exposure assessments are used in epidemiology studies, risk assessments, analysis of trends, and risk management decisions.

Exposure Sources

Most individuals in the United States spend the majority of their time indoors. See Attachment 2. In some cities, such as Houston, people spend approximately 90 percent of their time indoors. Outdoor pollutants may be brought inside through open windows, ventilation systems, food, water, tracked-in soil, and consumer products. These pollutants may even undergo chemical reactions once inside a building or home producing yet other pollutants. While ambient air toxics can penetrate into homes, offices, and cars, many chemicals, classified as air toxics under the Clean Air Act, are also emitted directly into the indoor air from consumer and cleaning products and building materials. Carpet, paint, and air deodorizers may all release chemicals into the indoor environment. Even taking a hot shower, washing dishes or clothes in hot water, may release chemicals, such as chloroform. (Wallace et al., 1993).

In addition, some emissions near a person's face can contribute significant concentrations to personal exposure, while contributing a negligible amount to ambient concentrations. Wearing recently dry-cleaned clothing is an example. (Wallace et al., 1993). Smoking is another example. Smoking accounts for the largest percentage of personal exposure to benzene, yet the activity of smoking releases little benzene into the surrounding air.

Thus, when the contribution of outdoor sources is minimal compared to indoor sources or the air immediately surrounding an individual, ambient air emissions are not a good indicator of personal exposure. It is therefore important to determine indoor air concentrations, the sources of those concentrations and the relative contribution from outdoor, indoor and personal sources in determining what people are really exposed to in their daily lives.

Personal Exposure Studies

Several studies have been carried out to assess the relationship among outdoor, indoor, and personal air to determine the sources of the exposure to air toxics. The most comprehensive U.S. study to date has been the Total Exposure Assessment Methodology (TEAM) study. This study was conducted in phases from 1980–1987 (e.g., Wallace et al., 1987, 1988). In addition, Phase I of the National Human Exposure Assessment Survey (NHEXAS), conducted from 1995–1997 (Pellizzari et al., 1995, Sexton et al., 1995) also examined this relationship. The major purpose of the TEAM study was to measure the personal exposures to select chemicals in urban populations in several U.S. cities. One phase of the TEAM study examined personal exposures of 600 people to a number of toxic or carcinogenic chemicals in the air and drinking water. One central hypothesis of the TEAM study was that emissions from major industrial sources in urban areas would be the primary source of the personal exposures to volatile organic compounds of study participants who lived in these areas. In addition, it was further surmised that these industrial sources would be the major source of indoor air pollutant concentrations.

However, one of the primary findings of the TEAM study was that for air toxics, indoor sources were the primary contributor to indoor air concentrations and to personal exposures for the majority of air toxics measured. See Attachment 3. Researchers determined that in many instances, the contribution of outdoor air toxics concentrations to personal exposure was negligible. The TEAM study concluded that it was sources other than outdoor air, that were controlling indoor and personal air concentrations.

The NHEXAS study was designed to determine population-base exposures to select air toxics, $PM_{2.5}$ and pesticides in urban, suburban and rural settings. NHEXAS pilot study results were similar to that of the TEAM Study. (The full NHEXAS study has not yet been initiated.)

There are instances where outdoor sources may be primary source. If compounds have minimal or no indoor sources, then penetration from outside source contaminants can be the dominant source. For example, carbon tetrachloride has been banned from use in consumer products, but has a long residence time in the ambient air. Thus, outdoor air is the source for the indoor air levels and personal exposure to this compound. (Baek, 1997).

Outdoor sources may be a significant contributor to indoor and personal exposures in homes immediately adjacent to ambient sources, such as factories, parking garages, heavily trafficked streets or dry cleaners. One current study, The Relationship Among Indoor, Outdoor, and Personal Air (RIOPA) Study, being conducted by the Environmental and Occupational Health Sciences Institute, is evaluating this hypothesis. The RIOPA study is examining this relationship in 100 homes in three

urban areas (Houston, Texas; Los Angeles, California; and Elizabeth, New Jersey). All of these homes are near major outdoor sources of air pollutants or in heavily trafficked areas. In these homes, researchers are placing monitors outside and inside the home to measure concentrations of select compounds. In addition, participants will wear a personal monitor for 48 hours and keep a diary of their activities during this time period. The RIOPA study is measuring select VOC, aldehydes, and $PM_{2.5}$ in a 3-year study. Some of the pilot study results are attached as Attachment 4. This study will provide specific information on the impact of outdoor sources of air toxics to personal exposures for residents living close to ambient source concentrations.

Future Research Directions

Only by understanding the relationship among outdoor, indoor and personal exposures can public health impacts be assessed. Additional research on indoor air, including indoor air chemistry (what happens to air pollutants in a home or building) and the sources of such concentrations needs to be examined. Additional research on the relationship among outdoor, indoor and personal exposure needs to be conducted. While an exposure research program exists for particulate matter, there is no such overall integrated program for the 188 air toxics listed in Section 112 of the Act.

Exposure is the link between ambient air concentrations and public health impacts. A dialog is needed about the role of ambient air toxics monitoring in exposure research along with the role of monitoring microenvironments and "hot spots" and their relationship to personal exposure.

Conclusion

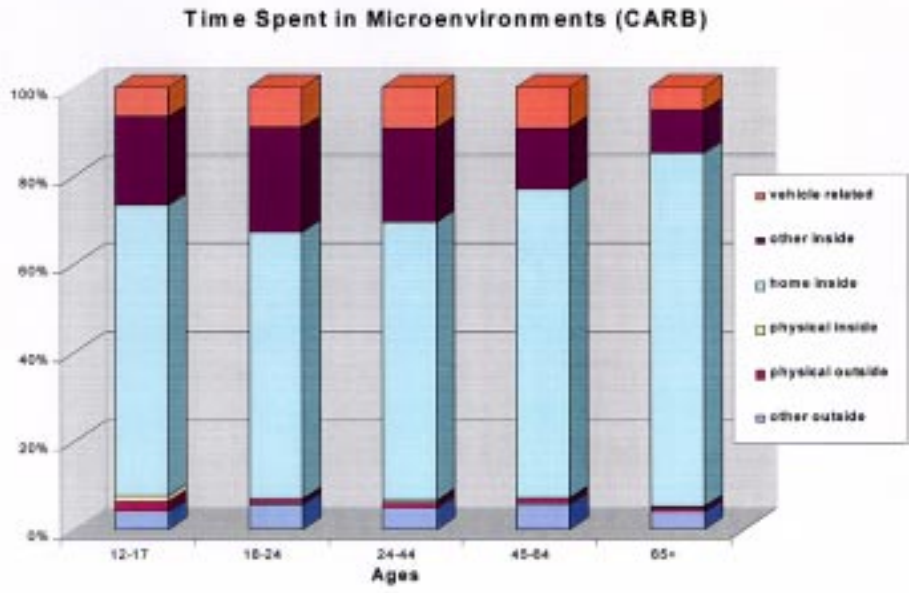
It is personal exposure to air pollutants, and not air concentration that is the critical component in assessing the public health impacts from air pollutants. Science has now established that indoor air pollutants can be a major contributor to a person's overall exposure to air pollutants. In addition, the findings from these studies indicate that the same air pollutants subject to regulation under the Clean Air Act are often found at much higher levels indoors. The Clean Air Act Amendments of 1990 rely solely on the assumption that outdoor levels are determinative of an individual's exposure and hence risk. The Act does not address the contribution of indoor sources of air pollution or the differences between indoor and outdoor quality.

Absent information about personal exposures, the real public health risk of air toxics cannot be accurately assessed. Merely reducing the ambient emission levels may not result in improved public health. By focusing on exposure, we can determine where the greatest risk to public health lie and tailor the solution to correct the problem. The Leland Center will continue to focus our research on addressing the critical area of exposure, thus allowing for a more cost-effective approach to protecting public health under the Clean Air Act.

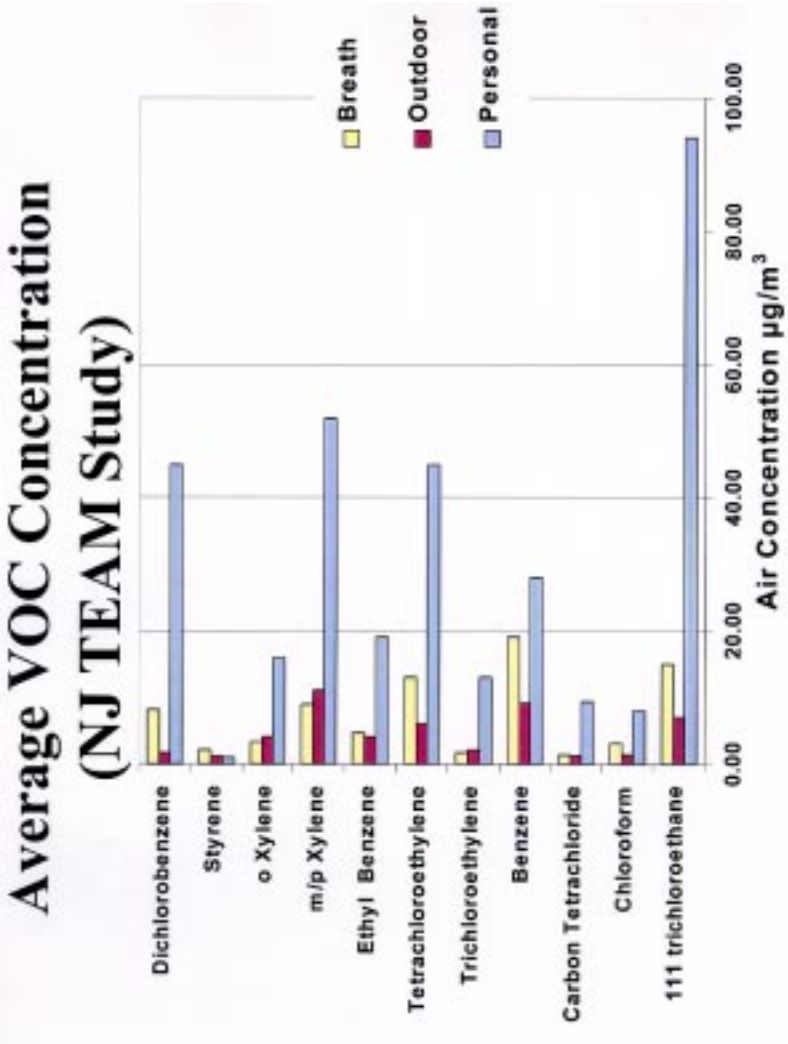
SEXTON ET AL.		NATIONAL RESEARCH COUNCIL	
EXPOSURE ESTIMATORS	COSTS AND ABILITY TO PREDICT/CLASSIFY EXPOSURES	EXPOSURE ESTIMATORS	APPROXIMATION TO ACTUAL EXPOSURE
• Poduction Volumes • Emission Inventories	Generally Lower Cost and Limited Accuracy	• Residence or Employment in Defined Geographic Area (e.g., county of the emission source/site)	Poorest
• Environmental Concentrations - Models - Measurements	↓	• Residence or Employment in Geographic Area in Reasonable Proximity to the Emission Source Site	↓
• Microenvironmental Concentrations - Models - Measurements	↓	• Distance from Emission Source/Site or Duration of Residence	↓
• Human Contact - Models - Measurements	↓	• Distance from Emission Source/Site and Duration of Residence	↓
• Internal Dose - Models - Measurements	Generally Higher Cost and Better Accuracy	• Quantified Surrogates of Exposure (e.g., estimates of drinking water use)	↓
		• Quantified Area or Ambient Measurements in the Vicinity of Residence or Location of Other Significant Activities	↓
		• Quantified Personal Measurements	Best

Source: Perlin et al, in press.

Time Spent in Microenvironments (National)



National Activity Pattern Survey (NHAPS) Data, EPA/600/R-96/148



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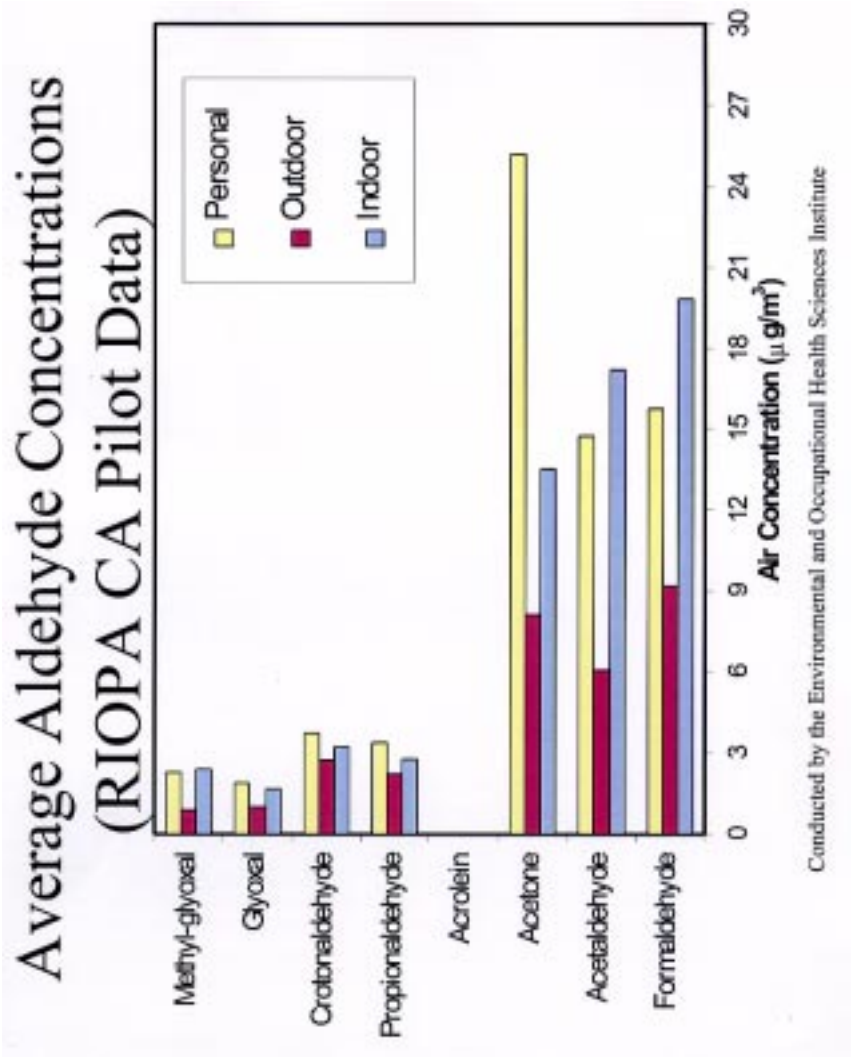
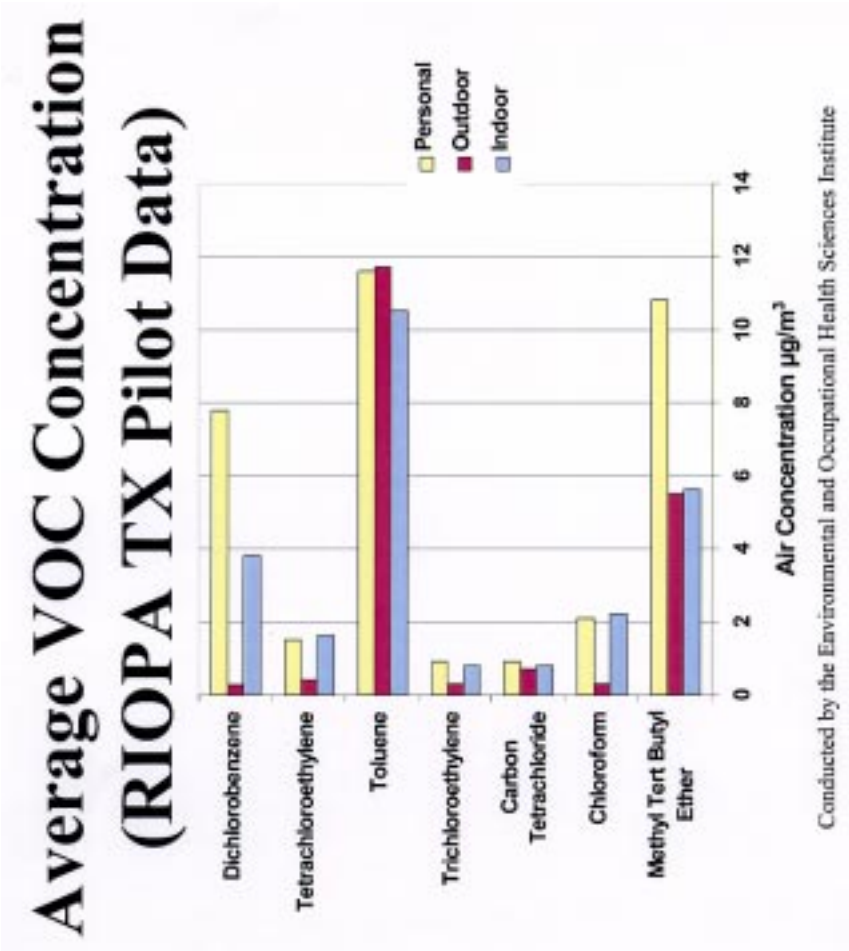

Average Aldehyde Concentrations
(RIOPA CA Pilot Data)
Methyl-glyoxal
Glyoxal
Crotonaldehyde
Propionaldehyde
Acrolein
Acetone
Acetaldehyde
Formaldehyde
Personal
Outdoor
Indoor
0
3
6
9
12
15
18
21
24
27
30
Air Concentration (μ g/m³)
Conducted by the Environmental and Occupational Health Sciences Institute



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RESPONSES BY ALLISON KERESTER TO ADDITIONAL QUESTIONS FROM SENATOR BAUCUS

Question 1. How would the CAA need to be adjusted, if at all, to ensure that regulatory actions are based on exposure? Please provide any specific recommendations and comment on the data collection and information management system and resources that would be necessary to more comprehensively incorporate exposure considerations in regulation development.

Response. Regulatory actions are based on risk. Risk is a function of both exposure and hazard. Exposure is the link between ambient concentrations and public health impacts. In considering exposure, the relationship among outdoor, indoor and personal exposures needs to be assessed, along with the sources of those exposures. Models that equate ambient levels of air toxics with exposure may not accurately characterize exposures to these substances and thus, may not result in regulatory decisions that would produce real health benefits. Consideration of personal exposure and the role of indoor air tonics in developing criteria documents, exposure models, in EPA's, implementation of the Agency's Integrated Urban Air Toxics Strategy and Residual Risk program, and in the design of ambient monitoring networks would help ensure that the potential health risks of air pollutants are more adequately characterized.

Question 2. You indicated that it might be possible to reduce indoor air pollution exposure by changing the products or systems used in the home. What do you consider to be the products or systems in homes of the highest concern relative to conducting more research on their human health effects? What role, if any, would be appropriate for the Federal Government in addressing indoor air exposure?

Response. Only by understanding the relationship among outdoor, indoor, and personal exposures can the public health impacts of air pollutants be assessed. Additional research on indoor air, including indoor air chemistry, and the sources of such air pollutants is needed. In addition, continued research on the relationship among outdoor, indoor, and personal exposures, the sources of those exposures, and whether those exposures actually result in adverse health effects needs to be conducted before such recommendations could be made as to changing products or systems used in the home. The Federal Government can foster this needed research.

Question 3. You mentioned that studies show that Americans spend a majority of their time indoors. Is there evidence that certain populations—children, construction workers, athletes—spend considerable more time outdoors that the "average" American? Is there evidence of socioeconomic differences in time spend (sic) outdoors?

Response. The study indicating that the Americans spend the majority of their time inside is the "National Activity Pattern Survey" conducted by the Environmental Protection Agency. EPA/600/R–96/148. This study broke out the activity pattern by age, starting with the 12–17 years old category. Children younger than 12 were not included. In addition, the California Air Resources Board (CARB) funded a similar study, with comparable results ("Measurement of Breathing Rate and Volume in Routinely Performed Daily Activities",

Contract No. AO33–205, June 1993). CARB also conducted a separate activity pattern study of children under 12. ("Study of Children's Activity Patterns" Final Report, Contract No. A733–149, September 1991) However, CARB has not conducted much analysis by occupation, because of the sample size limitations. Other studies have examined construction workers and athletes, more from an activity level perspective. Some papers by Samoo et al has been published on construction workers .

Question 4. You criticize the CAA for equating air concentrations with adverse health effects, suggesting that EPA does not consider exposure. In addition to epidemiological information, toxicological information is critically important to relating

concentrations with adverse effects. And, inhalation studies are already a basic component of EPA's scientific assessment of air pollution impacts. Please comment.

Response. Traditionally, the extent to which the general population is exposed to air tonics has been determined by monitoring programs that utilized concentrations of the pollutant as determined by a fixed site ambient air quality monitor. Epidemiological studies have used this information to assess the potential health risks from air toxics exposures to the general population. However, a number of studies involving measurements of personal exposures to air tonics have suggested that the correlation between outdoor concentrations and personal exposures to these pollutants may not be adequately determined by centrally located fixed site ambient monitors. EPA's current exposure models are based on ambient concentration levels, not on personal exposure data. In addition, these models have not addressed the relationship among outdoor and indoor air quality in contributing to personal exposures to air toxics. Thus, although EPA considers "exposure" in determining risk, the Agency's current approach may not accurately characterize the real risk of air toxics and other air pollutants to urban populations.

Question 4. Do you agree with Dr. Graham's testimony that the issue of whether breathing air pollution is harmful is a "spurious" technical debate, which is unlikely to be resolved conclusively at the low levels of air pollution now found in the USA due to the limitations of modern scientific methods of toxicology and epidemiology?

Response. The issue of whether breathing air pollution is a "spurious" technical debate is best answered by Congress itself and EPA. Science cannot always resolve issues with 100 percent certainty. However, research continues to indicate a link between air pollution and adverse health effects. Ongoing research, such as the personal exposure research, will help provide useful data about the exact air toxics urban populations are exposed to and the sources of those exposures. This information, will in turn, provide a basis for a more accurate assessment of the potential health effects of such exposures. Decisions makers must determine what is the necessary level of scientific certainty on which to base regulatory actions.

RESPONSE BY ALLISON KERESTER TO ADDITIONAL QUESTION FROM SENATOR MOYNIHAN

Question: You state, on average, 90 percent of a person's time is spent indoors. I agree that we need to improve the quality of indoor air and that this statistic is compelling evidence of the urgency of this issue. Do you also agree that since the air that we breathe—indoor and outdoor—originates outside, efforts to improve ambient air quality are also critical to improving human health?

Response. Yes, I agree that efforts should be made to improve ambient air quality. While several scientific studies suggest that the primary source of hazardous air pollutants (the 188 substances listed in Section 112 of the Clean Air Act Amendments of 1990), may be from indoor sources, the primary source for other air pollutants, such as ozone and particulate matter, appears to be the ambient air. Thus' it is important to understand the relationship among outdoor, indoor, and personal exposures to air pollutants and the sources of the exposures. Such information will help produce more accurate air pollutant risk assessments.

STATEMENT OF JOHN D. GRAHAM, DIRECTOR, CENTER FOR RISK ANALYSIS, HARVARD SCHOOL OF PUBLIC HEALTH

My name is John Graham. I am Professor of Policy and Decision Sciences at the Harvard School of Public Health where I teach graduate courses on risk assessment, risk communication, and cost-benefit analysis. I am also the founding Director of the Harvard Center for Risk Analysis, a mission-oriented Center dedicated to promoting a more reasoned public response to health safety, and environmental hazards. Our Center applies formal analytic tools to the following four issues: environmental health, automotive safety, medical technology, and food safety. I am the author or co-author of seven books and over 100 articles published in peer-reviewed scientific journals. In 1995–96 I served as elected President of the intonational Society for Risk Analysis, a membership organization of 2,500 scientists and engineers dedicated to applying formal analytic tools to the resolution of risk issues. I am offering personal testimony today and thus my remarks do not necessarily represent the viewpoints of the University or the Society for Risk Analysis.

It was about 10 years ago that I first testified before this Committee on President Bush's proposal to amend the Clean Air Act, a proposal that Congress expanded into what became the 1990 amendments to the Clean Air Act. We have learned a great

deal during the past decade. The Clean Air Act has produced more regulations, more public health and economic benefits, and more costs to American businesses and households than any other Federal program of environmental regulation. Thus, the stakes in the reauthorization debate are large.

Let me begin with some good news.

First, the total estimated benefits of the 1990 amendments appear to be greater than the total estimated costs of the amendments (EPA, 1999), at least if we are to believe EPA estimates of benefits and costs (see cautionary remarks below). But some parts of the 1990 Amendments are better "buys" than others (Smith and Ross, 1999). There are a significant number of clean air regulations that were adopted without a careful analysis of their risks, costs, and benefits (e.g., some of the MACT standards under Title III of the 1990 amendments). In many cases EPA estimates regulatory costs but does not attempt to quantify benefits in public health or economic terms (see, for examples EPA's regulatory impact analyses (RIAs) of the rules governing medical waste incineration and vehicle inspection and maintenance). Moreover, one study of 25 clean air rules adopted from 1990 to 1995 found that only ten of these rules would pass a strict cost-benefit test (Hahn, 1995). Thus, EPA's commitment to cost-benefit analysis varies enormously from rule to rule and the influence of cost-benefit analysis on EPA decisionmaking is uneven (Morgenstern, 1997, Hahn, 1999).

Second, the "grand experiment" with incentive-based programs under the Act, particularly the sulphur-trading programs enacted to address acid rain, appear to have been a qualified success (Staving, 1998). Evaluations suggest that this program has been successful (compared to conventional "command-and-control" regulation) both economically and environmentally. A case is now being made to expand this approach to trading of nitrogen oxides as well as sulphur oxides.

Third, as predicted (Graham 1985), EPA has made greater progress in regulation of air toxics through a technology-based approach that targets industry sectors ("source categories") rather than by determining acceptable risk on a pollutant-by-pollutant basis. Yet measuring success by the number of industries regulated is not very meaningful to public health. The big unknown in the toxics arena is whether the public health benefits of reduced human exposures to air toxics have been significant enough to justify the significant expenditure of agency and industrial resources that has taken place.

In my testimony today, I will focus on the role of risk analysis and cost-benefit analysis under the Clean Air Act. I will identify five problem areas that I believe are worthy of future Committee investigation as you develop legislation to reauthorize the Clean Air Act. In some cases I have only been able to identify a problem while in other cases I go further and recommend some possible solutions for your consideration.

Problem 1: Some provisions of the clean air act are dysfunctional because they do not require or permit EPA to weigh the risks, costs, and benefits of alternative policies.

When multi-billion dollar rulemaking decisions are made, it is inevitable that regulators will consider the consequences of their actions as well as the reasonableness of the relationship between risks, benefits and costs. Yet some provisions of the Clean Air Act erect a legal fiction that regulators may not consider risk, cost and benefit when devising regulations. This legal fiction is dysfunctional because it (1) reduces political accountability for value judgments and political choices, (2) hides from public scrutiny claims that are made about risks, benefits and costs (since such claims are driven "underground" in the course of regulatory deliberations), (3) undermines EPA's credibility in the regulated community and the public because the agency is portrayed as being disinterested in science and economics, and (4) shifts public debate from risk-benefit and cost-benefit issues (which is where the debate should be) to spurious technical debates about whether breathing air pollution has been proven to be harmful (the "causation" issue, which is unlikely to be resolved conclusively at the low levels of air pollution now found in the USA due to the limitations of modern scientific methods of toxicology and epidemiology). Let me provide a concrete example of how legal restrictions in the Clean Air Act create a perverse public debate about clean air policy.

The primary ambient air quality standards for ubiquitous ("criteria") air pollutants are to be set at levels that are safe in the sense that such levels protect the public health with an adequate margin of safety. Yet such scientific information (alone) does not typically provide an intelligible basis for He setting of safe (yet nonzero) amounts of air pollution. Human and animal studies often find no discernible threshold in the dose-response function, particularly as more susceptible subpopulations are identified and more subtle health effects are considered to be "adverse" within the meaning of the Clean Air Act. The only concentration of some air pollut-

ants (e.g. fine particles and lead) that is really safe to breathe appears to be zero, yet it is not economically realistic or appropriate for EPA to set air pollution standards at zero. Thus, EPA is forced to manufacture spurious rationales for non-zero air quality a form of dishonest behavior that contributes to the atmosphere of arbitrariness, mistrust, and adversarialism (including litigation) that has characterized public debates about air quality standards.

The solution to this predicament is not necessarily to apply a strict cost-benefit test to any new or modified primary air quality standard. Cost-benefit analysis of primary air quality standards is particularly speculative because air quality standards, which need to be based primarily on public health data, are devised before the agency has had the opportunity to study the industrial economy and collect the kinds of engineering and cost information that identify cost-effective ways to prevent or control pollution. When EPA or the States propose emissions rules for specific industries or sources, it is feasible to gather more precise cost and effectiveness information, thereby supporting a more rigorous analysis of risks, benefits and costs.

Although it is feasible for EPA to make crude estimates of risk, benefit, and cost when a new or modified primary air quality standard is proposed, the cost-benefit test for decisionmaking at this stage should be a more lenient one than is applied to Federal or State emission standards that apply to particular technologies or industries. For example, Congress might permit or require EPA to consider whether the incremental costs of a tighter air quality standard are grossly disproportionate to the anticipated benefits of the proposed standard. Under this rather lenient cost-benefit test, EPA's recent fine particle standard would have been quite defensible, though the proposed modification to the ozone (smog) standard would have been vulnerable to legal challenge.

Problem 2: Although clean air regulations are intended to reduce risks to public health, they sometimes cause unintended dangers to public health because the risks of regulation were not analyzed carefully by Congress and EPA when policies were made.

Risk-tradeoff analysis (sometimes called risk-risk analysis or risk-benefit analysis) is often easier than cost-benefit analysis because the units of measurement in the analysis are physical rather than monetary quantities. For example, the units used in risk-tradeoff analysis might include the net number of lives saved, life years saved, quality-adjusted life years saved, or even the net change in the amount of pollution emitted into the environment, with the mass emissions of each pollutant Freighted by their relative toxicity and/or exposure potential. In risk-tradeoff analysis, the public health benefits and risks of a new regulation do not have to be expressed in dollar units, one of the more complicated and controversial steps in economic evaluation. In order to avoid perverse situations where a well-intended clean air regulation kills more people than it saves, Congress should consider an amendment to the Clean Air Act Cat compels a risk-tradeoff analysis of future regulations (Graham and Wiener, 1995).

Experience the 1990 amendments illustrates trait Congress and EPA have not been as vigilant in conducting risk-benefit analysis as perhaps they should have been. Here are two examples:

First, EPA's new air quality standards were overturned by a divided appeals court that employed some novel constitutional arguments. Yet less attention has been devoted to the fact that EPA's revised smog standard was overturned by a unanimous court because EPA did not perforce a risk-benefit analysis of the proposal (computing the health benefits of smog reduction to the health risks of greater ultraviolet radiation exposure that would result from diminished smog concentrations in the atmosphere). Public exposure to ultraviolet radiation is a serious public health concern since such exposures are associated with skin cancer, cataracts, and other adverse health effects. EPA contests whether the health risks caused by regulations are legally relevant under the language of the Clean Air Act but Congress should take a broad view of public health protection and require EPA to do "More good than harm." to public health in each regulation (Warren and Marchant, 1993).

Second, Congress and EPA mandated an increase in the oxygenated content of gasoline without performing a careful risk-benefit analysis of the most important chemical, MTBE, that has been used to comply with the provisions in the Clean Air Act More oxygen content in gasoline did promise air quality benefits: less carbon monoxide and toxic air pollution. Yet the risks of the rule were not considered carefully. Now that MTBE, a rather persistent chemical with low acute toxicity, has been discovered in both surface and groundwater (e.g., near leaking underground storage tanks), questions have been raised about whether MTBE exposures pose a risk to public health. A recent EPA stakeholder panel chaired by Mr. Dan Greenbaum of the Health Effects Institute recommended that EPA repeal or modify the

mandate of oxygenated fuels, yet a careful risk-benefit analysis of the issue has still not been conducted by EPA.

Asking Congress and EPA to perform risk-benefit analysis is equivalent to asking for adherence to the Hippocratic oath in medicine: We should be vigilant about informing the public of the health risks and health benefits of clean air regulations, even in cases where some degree of risk is judged to be acceptable in light of the benefits.

Problem 3: Congress and EPA sometimes pursue clean air goals without taking account of other national objectives such as energy policy and international trade policy.

Although the public health objectives of the Clean Air Act are compelling, they do need to be pursued with sensitivity to other national policy objectives such as energy policy and international trade policy. Two recent examples of policy conflict have caught my attention. .

First, a recent trip to Europe, I discovered an interesting difference between European and American policies. I was surprised to learn that a large and growing fraction of passenger vehicles (cars and light Uncles as well as heavy trucks and buses) in Europe are powered by diesel engines. European vehicle manufacturers are also making major investments in advanced diesel engine technology that will reduce emissions of pollutants such as particulate matter and nitrogen dioxide. Yet the European Union regulations for nitrogen dioxide emissions may prove to be less stringent than California and USEPA regulations for an interesting reason. Europe is developing the diesel engine as an important element in the strategy to conserve energy and reduce carbon dioxide emissions, as required by the Kyoto treaty on global climate protection. Modern diesel engines are significantly more fuel efficient than gasoline-powered engines and therefore offer significant promise as a strategy to control carbon dioxide pollution. Vehicle fuel efficiency in Europe also offers significant economic benefits to consumers, since fuel prices in Europe are $3 to $5 per gallon and diesel fuel is priced louver than conventional gasoline.

In the United States, domestic vehicle manufacturers are also under political pressure to improve the energy efficiency of engines, but here we have very low fuel prices and consumers have shown a remarkable degree of interest in sport-utility vehicles (large and small), jeeps, and light trucks. There has been some interest in the use of diesel engine technology to power large sport-utility vehicles (in order to increase fuel efficiency) but the strict posture clean air regulators in the California and USEPA are discouraging use of the diesel in favor of less energy-efficient alternatives such as compressed natural gas and conventional gasoline. I have recently persuaded one of my doctoral students to conduct a risk-benefit analysis of the modern diesel engine because European and American policies toward this technology arc currently so divergent.

Second. EPA's toxic air pollution star cards applied to the coke production industry (so-called MACT and LAER standards) were designed to be "technology forcing" but have appeared to have had some unintended consequences in international trade. Coke is vital ingredient in the steelmaking process. Making coke from coal is a dirty process, though the industry has made significant progress in reducing pollution from coke batteries. The 1990 amendments to the Clean Air Act were designed to make greater progress by requiring 0 percent door emissions from any new coke plants built with conventional byproduct recovery technology. The theory was that this de facto prohibition on the traditional method of making coke would stimulate development of new and cleaner methods of making coke in the USA.

Preliminary experience with the 1990 amendments suggests that coke and steel makers have not always responded to the Act by making major new investments in clean coke-making technology (Graham and Hartwell, 1997). Although a few domestic firms have made major investments in different coke-making technologies, a number of integrated steel makers are instead phasing out their coke-making facilities and purchasing coke on the open market. Some steelmakers are making arrangements to import coke from a variety of countries in Eastern Europe and Asia (e.g. China), where more coke plants are being built with conventional technology and where batteries are operated with greater air emissions gases end particles than is typical of facilities in the United States. I recommend that the Committee follow the dynamics of this industry to determine whether the 1990 amendments are producing the consequences for clean air and international trade that were anticipated when the legislative compromise was negotiated in 1990.

Problem 4: The risk analyses used by EPA to make public health determinations are not always clear, objective, open to public scrutiny, and rooted in the best available science.

The problems the agency faces in using public health science in risk assessment are important to sound implementation of He Clean Air Act but these same prob-

lems affect EPA's implementation of other environmental laws, such as the Safe Drinking Water Act and the Resource Conservation and Recovery Act. Here I shall cite several examples to illustrate the general point that Congress needs to take greater interest in the scientific integrity of EPA's public health determinations and the technical processes of risk assessment that support these determinations.

First, cancer-risk determinations will play a critical role in EPA's implementation of the residual-risk provisions of CAAA–90, yet EPA has still not modernized it's cancer risk assessment guidelines to account for advances in biological understanding of the mechanisms of cancer induction. These advances can have a critical impact on which chemicals are classified as "carcinogens" for regulatory purposes and what dose-response relationships are assumed in quantitative modeling of cancer risk. EPA has proposed reforms but is moving at a slow pace to adopt them. The agency's recent decision to ignore mechanistic science regarding chloroform has sent a signal in the scientific community of the agency's weakened commitment to modernize methods of cancer risk assessment (Chloroform is a chemical shown to cause cancer in animals at high doses that mechanistic science suggests is unlikely to cause human cancer at low doses).

Several years ago I served on a Science Advisory Board (SAB) Committee charged with assisting EPA in performing its reassessment of dioxin, a chemical of clear regulatory significance that has been the subject of extensive scientific study. EPA prepared a lengthy draft risk assessment but, despite several years of "talk", has never attempted to respond to the written comments of the SAB Committee and has not issued a final risk assessment of dioxin. When EPA falls years behind its published schedule to make progress in risk assessment, it undermines the credibility of the agency as well as the agency's risk assessment process. The Congress should look into what is happening to cancer risk assessment at EPA.

Second, a mayor National Research Council Report (1994), Science and Judgment in Risk Assessment, made numerous recommendations aimed at enhancing the quality and transparency of EPA's risk assessment process. With the exceptions of some notable improvements in human exposure assessment, the bulk of the NRC recommendations have not yet been implemented by EPA. EPA's recent report to Congress on plans to implement the residual risk provisions of the Clean Air Act makes very little use of the NRC report or of a subsequent report by the Commission on Risk Assessment and Management appointed by Congress and the President As Congress considers reauthorization of the air toxics provisions of the Clean Air Act, they should examine why EPA has given relatively little priority to improving the agency's risk assessment and management processes.

Third, the controversy over EPA's effort to establish a new primary air quality standard for particles illustrated how EPA may seek to use scientific studies whose original data are not available for public scrutiny. Two important studies of the chronic health impacts of breathing fine particulate matter (Dockery et al, 1993; Pope et al 1995) were cited by USEPA in support of the new particle standard but the agency has not succeeded in making the original data from these studies available for public scrutiny. The Health Effects Institute has played a constructive role in reviewing and reanalyzing these original data but the goal of providing public access to original date supporting regulatory determinations has not yet been accomplished under the Clean Air Act. The Office of Management and Budget is currently working on implementation of a congressional requirement to solve this problem for future rulemakings; the success of OMB's effort should be followed closely by the Congress.

Finally, EPA continues to publish benefit estimates for the Clean Air Act that are based on a dubious "value-of-statistical life" (VSL) method. As employed by EPA the same VSL is applied in all situations, regardless of whether a citizen: loses 1 year of life expectancy or 40 years of life expectancy from air pollution. The VSL method also ignores the functional quality of the life years that are lost. Better methods are available in the field of health economics but EPA does not yet use them.

Problem 5. Congress and EPA continue to be preoccupied with outdoor air pollution, even though a substantial body of scientific information suggests that indoor air pollution is a more serious public health problem.

The legislation we are discussing today would more appropriately be entitled the "OUTDOOR Clean Air Act" because the provisions of the law and the resulting compliance expenditures made by industry and households are devoted primarily to reducing exposure to outdoor air pollution from outdoor sources. Controlling outdoor sources of air pollution will have secondary benefits inside homes and offices because outdoor air pollution is a significant cause of indoor air pollution. Yet Tic major sources of indoor air pollution are not regulated by the Clean Air Act (c.g., environmental tobacco smoke, naturally occurring radon gas, and a variety of building materials, consumer products, and cooking practices). As a country, we have

made so much progress in reducing outdoor sources of air pollution that leading scientists believe that indoor sources of air pollution are of equal or greater public health concern compared to the residual amounts of outdoor air pollution (Cross, 1990; National Research Council, 1991; Samet and Spengler (eds), 1991).

A recent conference stimulated by EPA and OSHA scientists arose out of recognition that efforts to control outdoor air pollution could inadvertently exacerbate levels of air pollution indoors (e.g., if the MACT regulations governing air toxics cause factories to reduce ventilation rates in buildings and concentrate pollutants indoors where workers will be placed at greater risk). Yet we have only scratched the surface ? public discussions of the indoor air quality issue because Congress has given the greatest priority to further regulation of outdoor sources of air pollution. The first reauthorization hearing of the Clean Air Act is a good the to consider whether some of the priority assigned to cleaner outdoor air could be better expended ? efforts to enhance the quality of indoor air.

Thank you very much for the opportunity to provide this testimony. I am certainly willing and eager to provide any additional information that could assist the Committee's reauthorization efforts.

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RESPONSES BY JOHN GRAHAM TO ADDITIONAL QUESTIONS FROM SENATOR BAUCUS

Question 1. In 1981, the National Commission on Air Quality stated: In the [Clean Air Act], Congress recognized that while the levels of air pollution at which public health is affected generally do not vary among different locations, the costs of meeting a specific standard can vary substantially from area to area, depending on the severity of the pollution. Thus, if a national air quality standard were based in part on the costs of complying with it, the high costs of meeting the standard in a few heavily polluted areas could result in the standards being set at a less protective level than is achievable in a reasonable, economic fashion in other areas.

Similarly, a few costly technologies or heavily impacted industrial sectors could skew the cost assessment of a national air quality standard. Please discuss this

issue in light of your suggestion that cost-benefit analysis be incorporated into derivation of national air quality standards.

Response. There is a fundamental problem with applying the same air quality standard to all States and localities, regardless of their degree of motorization or industrialization. Under current law, we maintain this fiction only by granting continued exemptions or waivers to regions of the country (e.g., Los Angeles) that are consistently out of compliance with primary ambient air quality standards. If a State or locality is willing to accept somewhat greater pollution levels in their community in exchange for economic benefits (e.g., industrial employment or greater use of automobiles), that is not necessarily an irrational judgment. Decades ago, there was fear that allowing some States to have weaker environmental standards than others would cause a "race to the bottom", with all States allowing more pollution to attract industry. Recent research by Professor Richard Revesz of New York University Law School has demonstrated that this "race to the bottom" theory is unfounded. It turns out that Governors and Mayors (as well as Senators) tend to care about air quality as well as economic prosperity. Even if a uniform national standard is maintained, it would be advisable to apply a cost-benefit test to each Federal rule or State Implementation Plan that is proposed to implement the national standard. Under this scheme, a strict national standard could be maintained even though inefficient rules aimed at particular industries or regions of the country could be rejected on cost-benefit grounds.

Question 2. Your testimony suggests that EPA does not always use credible science (or "sound science," as it is often referred to in Congress) in implementing the Clean Air Act. How would you define "sound science?" How should Congress determine what is "sound science" when legislating or conducting oversight? Is there a test of "sound science" that EPA should apply in the practice of developing air quality standards?

Response. There is no universal definition of credible or sound science. However, there are some important features of scientific information that make it more likely to be sound and credible. Such features of sound science include well-specified, a priori hypotheses, unbiased research designs, high quality methods of data collection, appropriate methods of data analysis, peer review, replication of key findings by independent investigators, public availability of original data for reanalysis (subject to reasonable confidentiality protections), and plausibility of results in light of other scientific knowledge (e.g., weight-of-evidence determinations). In applying these principles to specific scientific issues, there is certainly room for reasonable differences in scientific opinion. For a discussion of US organizations that have played a strong role in promoting sound science in regulatory policy, see S. Jasanoff, *The Fifth Branch: Science Advisors as Policy Makers*, Harvard University Press, Cambridge, MA, 1990; J. Graham (ed), *Harnessing Science for Environmental Regulation*, Praeger, Wesport, CN, 1991; M. Powell, *Science at EPA: Information in the Regulatory Process*, Resources for the Future, Washington, DC, 1999.

Question 3. In the peer review of EPA's 1997 proposal on very fine particulate matter ($PM_{2.5}$), 19 of the 21 Clean Air Scientific Advisory Committee members voted to recommend that $PM_{2.5}$ be regulated. However, the panel could not reach a consensus on the level at which $PM_{2.5}$ should be regulated; four panelists supported specific ranges of standards at the lower end of EPA's recommendations, seven supported specific ranges at the upper end, two did not think that a $PM_{2.5}$ standard was warranted at all, and the remaining eight supported the concept of a standard but declined to select a specific range or level. Generally speaking, how should Congress "read" a scientific peer review outcome such as this? How should EPA respond to such an outcome? Is there a general "rule" that Congress and EPA could use to judge when a regulatory body should act or not act in response to a mixed peer review?

Response. I have no opinion on how EPA or Congress should have reacted to the splintered peer review panel on particulate matter.

Question 4. Some argue that issues—such as principles of precaution, equity, environmental justice, and individual rights—need to be considered in the development of environmental standards. However, considerations of these issues do not fit neatly into either risk assessment or cost-benefit "tests." How and at what point should these issues be integrated into the standard setting process?

Response. Cost-benefit analysis, in its strictest form, addresses only quantifiable matters of economic efficiency. . Yet more practical formulations of the cost-benefit test allow for consideration of factors such as precaution, equity, environmental justice, and individual rights. See, for example, the cost-benefit test crafted by Senators Fred Thompson and Carl Levin in S. 746 (The Regulatory Improvement Act). This test, which was judged to be acceptable by the Clinton-Gore Administration, author-

izes decisionmakers to depart from strict cost-benefit reasoning in circumstances where the decisionmaker has compelling equity or other considerations. The Clinton Administration's Executive Order on Regulatory Planning also employs a practical cost-benefit test that allows consideration of values other than economic efficiency. flaw in the Clean Air Act is that, in various sections, it can be read to prohibit any consideration of economic efficiency (in effect allowing these other values to completely "trump" economic efficiency). .

Question 5. Your testimony suggests that the Clean Air Act's current standard-setting breaks down when it is confronted with determining "safe" levels for pollutants for which no threshold for adverse effects is discernible. However, carcinogens are commonly regulated, but they are typically treated as non-threshold pollutants and their "safe" levels are established based on health policy conventions related to acceptable risk. Similarly, the regulatory "safe" level (e.g., reference dose) for many threshold non-carcinogens is often not discernible and must be determined using safety factors based on health policy conventions. Does the failure of scientific data alone to define a clear "safe" level necessarily lead to "spurious rationales" for non-zero standards? Since the "science" is rarely certain, should the Agency and Congress make health-based policy judgments to estimate "safe" levels for environmental pollutants?

Response. For non-threshold pollutants, you are correct that "safe" levels of pollution are sometimes defined by reference to "health policy conventions" that define acceptable or negligible risk. Unfortunately, these conventions have no logical foundation (in philosophy or science) and thus it should not be surprising that the conventions are applied inconsistently in various arenas of environmental policy. The same level of cancer risk from involuntary exposure to pollution, for example, may be judged acceptable in one context or unacceptable in another context, with no mitigating factors providing an explanation for the difference. For a comprehensive review of these health-policy conventions, including their lack of philosophical and scientific foundation, see A. Rosenthal, G. Gray, I.D. Graham, "Legislating Acceptable Cancer Risk from Exposure to Toxic Chemicals," *Ecology Law Quarterly*, vol. 19, 1992, pp. 269–362. Health policy judgments should be based on a practical cost-benefit test rather than on mythology about what risks are "acceptable".

Question 6. Your testimony proposes that EPA use a "lenient" cost-benefit analysis to determine whether the incremental costs of a proposed national air quality standard are "grossly disproportionate" to anticipated benefits. Please define "grossly disproportionate" and elaborate on why you believe the fine particulate standard would pass this test, but the ozone standard would not.

Response. "Grossly disproportionate" is proposed as a more "lenient" standard than the "benefits must exceed costs" test that informs strict cost-benefit determinations. A careful reading of the EPA's Regulatory Impact Analysis on ozone and particulates reveals that the ozone standard might be vulnerable to judicial challenge because the quantifiable benefits are less than the costs, substantially so under several reasonable scenarios. The reverse is the case for the particulate standard, which has estimated benefits well in excess of costs. The only factor that might "save" the ozone standard is the long list of qualitative (non-quantifiable) benefits. However, there were also some categories of cost that EPA was unable to quantify.

Question 7. At the same time you propose a cost-benefit analysis be used to test a new or modified primary air quality standard, you state that the harms associated with air pollution are "unlikely to be resolved conclusively at low levels of air pollution now found in the USA due to the limitations of modern scientific methods of toxicology and epidemiology." Please explain how a cost-benefit analysis can effectively characterize the benefits of an air pollution standard when faced with the difficulty presented by this "causation" issue.

Response. The discipline of risk assessment was developed for circumstances where risks at low doses of pollution cannot be directly measured by epidemiology and toxicology. See Center for Risk Analysis, A Historical Perspective on Risk Assessment in the Federal Government, Harvard School of Public Health, Boston, MA, March 1994. Cost-benefit analyses commonly employ the results of risk assessments, which extrapolate the risks observed at high doses to low doses using various dose-response models. These estimates of risk can have large uncertainties, which is why it is critical for the cost-benefit analyst to be informed of these uncertainties in a quantitative manner. See National Research Council, *Science and Judgement in Risk Assessment*, National Academy Press, Washington, DC, 1994, Richard Morgenstern (ed), *Economic Analyses at EPA: Assessing Regulatory Impact*, Resources for the Future, Washington, DC, 1997.

Question 8. Some have asserted that cost-benefit analysis of environmental and occupational safety regulations puts the benefit side of the equation at an inherent

disadvantage. This is because estimates of compliance costs (e.g., dollar cost of installing new technologies at affected industries) are typically easier to produce and ostensibly "harder numbers" than estimates of benefits (e.g., dollar value of increased visibility or averted health harms at low levels of air pollution). The result, as asserted, is that an uneven, "apples and oranges" dynamic is created, leaving the benefit side of a cost-benefit in an inherently weaker position in the context of regulatory, political, and legal proceedings. Please comment on this issue.

Response. This concern has been expressed since I entered the field in 1980 and the concern is still expressed today. However, the concerns expressed today often do not recognize the dramatic scientific progress that has been made in quantifying and monetizing the benefits of health, safety, and environmental regulation. For a review of this progress, see G. Tolley, D. Kenkel, R. Fabian, *Valuing Health for Policy: An Economic Approach*, University of Chicago Press, Chicago, Illinois, 1994; R. Kopp, W.W. Pommerehne, N. Schwarz, *Determining the Value of Non-Marketed Goods*, Kluwer Academic Publishers, Boston, MA, 1997.

Question 9. Considerable concern has been expressed about the ability of cost-benefit analysis to properly address such issues as monetizing or quantifying positive benefits, scoping all relevant benefit categories, and calculating discount rates for future benefits. Cost-benefit analysis has been called a primitive art and its use is often said to be complicated, expensive, and controversial. This concern suggests that adding a "particularly speculative" cost-benefit analysis to the standard-setting process would not necessarily diminish, and may even add a new dimension to the atmosphere of arbitrariness, mistrust, and adversarialism that your proposal seeks to address. Please comment on this concern.

Response. Cost-benefit considerations are already a major part of the regulatory process, sometimes implicitly through the information supplied by stakeholders and sometimes explicitly through analyses prepared by agencies (e.g., under mandate of Presidential Executive Order). What creates mistrust and adversarialism is making decisions on two sets of books: one for stakeholders (which clearly does account for costs and benefits, however imperfectly and mysteriously) and one for journalists and the lay public (which exhibits a sneaky attitude that "costs were not a factor"). This overt dishonesty undercuts the credibility of the regulatory process and diminishes trust in government. (By the way, cost-benefit analysis was a primitive art in 1980 but is considerably more advanced today. It can certainly be improved in the future.)

Question 10. Are you aware of any studies on the accuracy of direct cost estimates related to individual Federal regulations? Do these studies suggest that these estimates tend to under- or over-estimate the direct costs of regulation?

Response. I believe that Richard Morgenstern of Resources for the Future has prepared a study on the validity of regulatory cost estimates. My recollection is that both types of errors were found but that errors of overestimation were more frequent than errors of underestimation.

Question 11. You indicated that, except for the acid rain and CFCs Titles, the CAA Amendments of 1990 largely flunk the cost-benefit test. By what margin? and what assumptions and methodology do you use to arrive at such a statement?

Response. My conclusions are based on EPA's own retrospective cost-benefit analysis of the 1990 Amendments to the Clean Air Act, analyses that were mandated in the Act at the insistence of Senator Moynihan and others. There is also a new analysis prepared by Charles River Associates that reaches a similar conclusion.

Question 12. In your testimony, you suggested that the oxygen content requirement for reformulated gasoline in the Clean Air Act Amendments of 1990 should have gone through a more careful risk-benefit analysis before being adopted by Congress. Most data suggest that that requirement has resulted in significant over-compliance with the air toxics emissions reductions goals, and provided carbon monoxide emissions improvements and overall improved air quality. The requirement did not dictate the use of MTBE. How should Congress have acted differently before establishing this requirement to assure that no less than the same environmental benefits would have accrued in the same time period?

Response. Before mandating oxygenation of fuels, Congress, EPA, and the Bush White House should have looked more carefully at the risks that might be created by the chemicals used to oxygenate fuels. Although Congress did not mandate MTBE per se, it was well known at the time that MTBE was likely to have an economic advantage over other oxygenates in several regions of the country. It was also known that MTBE is a highly persistent chemical and that there were leaks in many underground gasoline storage tanks throughout the country. (I do have some sympathy with the claim that the MTBE is a blessing that has exposed these leaks, though the full cost of plugging all these leaks needs to be calculated). Your expres-

sion of confidence in the environmental benefits of oxygenation is not fully supported by the findings of a recent report by the National Research Council, the operating arm of the National Academy of Sciences. Indeed, the original determination that the benefits of oxygenation would exceed costs and risks was never established by a careful, peer-reviewed analysis. You may also be interested in reading some of the analyses of MTBE that are now under review in the State of California, some commissioned by private parties and some commissioned by the State of California. Based on reading these draft analyses, I am not convinced that the oxygenates requirement is a reasonable policy.

Question 13. Section 109 of the Clean Air Act requires the establishment of ". . . ambient air quality standards the attainment and maintenance of which in the judgment of the Administrator, based on such criteria and allowing an adequate margin of safety, are requisite to protect the public health." This section seems to embody a regulatory philosophy much closer to the Hippocratic oath ("I will follow that system of regimen which, according to my ability and judgment, I consider for the benefit of my patients, and abstain from whatever is deleterious and mischievous") than your testimony suggests you support. You suggested that a clean air regulation should go forward so long as "we are doing [incrementally] more good than harm. " That position seems to contradict a common interpretation of the Hippocratic oath, which is "first, do no harm," not "do more good than harm." Please comment.

Response. The Hippocratic oath, as practiced in modern medicine, clearly gives credence to concerns about the side effects of treatment as well as the effectiveness of treatment. See J. Graham, J. Wiener, *Risk Versus Risk: Tradeoffs in Protecting Health and the Environment*, Harvard University Press, Cambridge, MA, 1995.

Question 14. At the hearing, you stated, "I think any careful environmental analysis of what is going on here would indicate that we are having less economic productivity in this country and we are having more air pollution in other countries." Please provide the Committee with references to any analyses in scholarly publications supporting this conclusion.

Response. The example I cited is the regulation of air taxies from the coke production industry under the 1990 Amendments of the Clean Air Act. This regulation has provided competitive economic advantage to importers of coke who are not subject to such stringent emission requirements and prohibitions on construction of new byproduct recovery batteries (through zero percent door-leak limitations). See J. Graham, J. Hartwell (ed), *The Greening of Industry: A Risk Management Approach*, Harvard University Press, Cambridge, MA, 1997, pp. 137–168. In his remarks, Senator Voinovich referred to related developments in his State of Ohio, which he observed (and tried to prevent) as Governor.

Question 15. Conducting the comprehensive cost-benefit analyses which you advocate as part of the regulatory process would seem to be significantly more resource intensive than the current system. Given that Federal discretionary funds are likely to continue to decline in the near future, it seems logical that the bulk of the new bureaucracy necessary to conduct these analyses would be funded through fees placed on those seeking permits to pollute or on those desiring to expose the public and the environment to new and potentially harmful substances. Please comment.

Response. I have no objection to taxing pollution as a means to fund more and higher quality analyses at agencies such as EPA. I want to emphasize that I would support taxing pollution, not economic production. The latter mistake was made by Congress when it designed finances for the Superfund Program, which taxes petrochemical companies without regard to the extent of their prior or current pollution.

STATEMENT OF RICHARD L. REVESZ, PROFESSOR OF LAW; DIRECTOR, PROGRAM ON ENVIRONMENTAL REGULATION, NEW YORK UNIVERSITY SCHOOL OF LAW

Mr. Chairman and Members of the Subcommittee: Thank you for inviting me to testify before you today. I would like to discuss a number of issues concerning the possible use of cost-benefit analysis under the Clean Air Act.

First, I will briefly explain the technique for valuing human lives that is generally employed as the starting point for the determination of the benefits of environmental regulation. This technique involves ascertaining the wage premiums demanded by workers employed in risky occupations who face a probability of death from industrial accidents. Second, I will explain why valuations based on such wage premiums need to be adjusted upward before they can be properly used in the context of environmental regulation. Third, I will show why certain downward adjustments of the value of life that have been advocated in certain academic and public

policy circles are in fact inconsistent with the technique of cost-benefit analysis and should not be performed. Fourth, I will explain why the discount rate used by the Office of Management and Budget (OMB) in its administration of Executive Order 12,866 is a great deal higher than rates supported by economic theory, and show that, as a result, certain environmental benefits are severely undervalued. Fifth, I will discuss how the Executive Order and various legislative proposals couple cost-benefit analysis with procedural devices designed to thwart regulation, rather than to make regulation more rational.

The issues discussed in Parts I, II, and IV of this testimony are discussed in more detail in an article that I recently published, which is attached as Appendix I.

I. VALUATIONS OF HUMAN LIFE IN WORKPLACE CONTEXT

The primary benefit of many important environmental statutes is the human lives that are saved. Thus, properly valuing human lives must be an important part of any cost-benefit inquiry.

Since the 1970's, willingness-to-pay studies have become the standard economic technique for placing a value on human life. By far the most common method for performing such valuations focuses on the choices that workers make in accepting risky jobs. The approach begins by defining sets of jobs that require comparable skills and offer comparable non-monetary amenities, except that one exposes the worker to a higher risk than the other. Presumably, a rational worker would not accept the riskier job unless she obtained sufficient compensation for the additional risk. The wage differential between the riskier and the less risky jobs is the compensation that the worker therefore is assumed to demand for the additional probability of death that she faces as a result of having taken the riskier job. The wage differential divided by the additional probability of death is then considered to be the value of life.

II. WHY CERTAIN UPWARD ADJUSTMENTS ARE NECESSARY

The value of life figures obtained from studies of risky occupations need to be adjusted upward to obtain a meaningful valuation of the benefits of environmental regulation. These adjustments must account for the generally involuntary nature of most environmental harms, for the differences between the median income of the workers who are the subjects of these studies and of the population as a whole, and for the dreaded nature of certain environmental contaminants (principally carcinogens). Not performing these necessary adjustment can result in an undervaluation of life by as much as a factor of six (or even more in certain contexts).

A. Involuntary Nature of the Harm

1. Valuations of Voluntary Versus Involuntary Risks

There is an extensive literature suggesting that individuals assign greater value to avoiding risks that are thrust upon them involuntarily than to risks that they incur voluntarily. The risk assumed by individuals who subject themselves to possible of industrial accidents is generally thought of as a risk assumed voluntarily. In contrast, the risk of exposure to environmental contaminants like air pollutants, is generally thought of as involuntary. As a result, if one takes the willingness-to-pay to avoid voluntary harms and imports that figure into the context of environmental regulation, there will be a systematic undervaluation of the benefits of regulation.

Determining the extent of the undervaluation, however, is complicated. In general, the economics profession favors "revealed preference" valuations, under which the value assigned to a good can be observed through a market transaction. Willingness-to-pay studies of wage differentials individuals demand to accept a risk of death are a prominent example of a revealed preference technique. In contrast, because involuntary risks are by definition not based upon informed market transactions, revealed preference techniques are not available to assess the value of involuntary harms.

Thus, in order to estimate how the valuations of involuntary and voluntary risks differ, one has to ask individuals directly the relative value that they attach to avoiding the two types of harms. The most comprehensive study of this type conducted a nationwide telephone survey of 1,000 households, asking interviewees to compare, among other pairs of risks, radon control in homes and a pesticide ban on fruits. The respondents also were asked to assess, on a ten point scale, the ease with which the respective risks could be avoided.

The respondents' answers revealed that they considered the radon risk more voluntary in that it could be avoided with greater ease. When the respondents were told that the two programs would save the same number of lives and cost the same,

72 percent chose the pesticide ban and only 28 percent opted for the radon control. The median respondent viewed saving 100 lives by means of the pesticide ban as equivalent to saving 213 lives through radon control. Thus, the median respondent implicitly found the involuntary risk to be twice as harmful.

2. Unrepresentativeness of the Population Exposed to Workplace Risks

Valuations of life in workplace settings are inaccurate as a measure of the value of life for environmental programs for a second reason. In a competitive marketplace, individuals who take relatively risky jobs by definition have the lowest willingness-to-pay to avoid the risk. Other things being equal, employers will pay the least possible amount to fill the jobs, so individuals with higher valuations will not be hired.

As a result, the willingness-to-pay valuations derived from the study of risky jobs are the valuations of a relatively small subgroup of the population with a disproportionate tolerance for risk. In contrast, most environmental risks affect a far broader sector of society. Thus, the valuations of the individual with the median valuation of risk (not an individual with an unusually low valuation) would be the appropriate metric to use in the valuation of life for cost-benefit analysis of environmental regulation. As a result, an appropriate correction needs to be made when extrapolating from the workplace to the environmental arena. Unfortunately, at this time there is no empirical literature that sheds light on the magnitude of such a correction. But if cost-benefit analysis becomes part of the decisionmaking process under the Clean Air Act, careful attention will need to be paid to this issue.

B. Impact of Income on the Valuations of Life

It is generally recognized that willingness-to-pay valuations of life, such as those obtained in the workplace setting, are a function of the income of the subjects of the study. Economists have estimated, for example, that a 10 percent increase in income leads to a 10 percent increase in the value of life. As a result, there are at least two problems with using the valuations from workplace studies for cost-benefit analyses of environmental regulation.

1. Distribution of Income Across Occupations

First, individuals who take risky jobs generally have lower-than-average income. Thus, there is a problem in extrapolating from the willingness-to-pay studies conducted in high-risk occupations to the broader population affected by environmental carcinogens.

The U.S. Census provides median and mean earnings for all workers and for various occupational categories. The category including operators, fabricators, and laborers is probably the best proxy for workers in risky occupations who are the subjects of empirical studies concerning the value of life. In 1996, the median and mean earnings for this category of workers were $16,883 and $19,981, respectively. In contrast, the corresponding figures for the population as a whole were $20,716 and $27,366, respectively. Thus, the median earnings of the population as a whole are 22.7 percent higher than the median for workers in risky occupations, and the mean earnings of the population as a whole are 37.0 percent higher. Adjustments of this magnitude therefore need to be performed to the valuations of life from the workplace setting.

2. Increases in Income Over Time

A second problem arises in connection with environmental risks that have a latency period, so that the death will not occur immediately but only after the passage of some time. Empirical studies show that individuals value their lives as a function of their current income, and not on the basis of projections of future income. But for latent harms, the valuation that individuals would have at the time of their death is what matters.

Over the last several decades, median and mean incomes in constant dollars have been rising at a compound rate of about 1 percent per year. Thus, for contaminants with a 20 year latency period (as is the case with some carcinogens regulated under section 112 of the Clean Air Act) an upward adjustment of about 22 percent would have to be made to the valuation of life from the workplace setting to make the figure appropriate for environmental regulation.

C. Nature of Carcinogenic Deaths

Particularly with respect to carcinogens regulated under section 112, an upward adjustment of the value of life to account for the dreaded nature of the harm also needs to be performed. Indeed, there is an important difference in the nature of deaths resulting from industrial accidents on the one hand and from environmental

exposures to carcinogens on the other. The former occur instantaneously and without warning. The latter often occur following a long and agonizing ordeal.

In addition to the loss of the life itself, two other components need to be valued in the case of carcinogenic harms: the very painful and often extended period of morbidity that precedes the death and the dread aspects of carcinogenic deaths. The leading empirical study in this area found that the valuation of life in the case of carcinogenic exposure is about twice as high as the corresponding valuation in the case of an instantaneous death from an unforeseen accident.

III. WHY CERTAIN DOWNWARD ADJUSTMENT ARE INAPPROPRIATE

Some policy analysts have suggested that downward adjustments of the value of life obtained in workplace studies must be performed to account for the fact that the beneficiaries of certain environmental programs are older individuals, and that these individuals are often not in good health. The question of how cost-benefit analysis should account for the particular features of the population benefited by environmental regulation is very complex. In any event, however, the particular downward adjustments that have been advocated are inconsistent with a proper understanding of economic theory.

A. Treatment of Older Individuals

One important pitfall to be avoided concerns the manner in which cost-benefit analysis deals with programs designed to benefit older individuals, particularly individuals in their seventies and above. Some academics and policy analysts argue that, in computing the benefit of an environmental program designed to save the lives of such individuals, their remaining life expectancy should be multiplied by the value of a life year. In turn, they assert that values of life years should be computed by assuming that workers who take risky jobs (whose median age is about 40) value each of their remaining years the same amount, and that their valuation of life can therefore be broken down into a value for life years. So, for example, making just a minor simplification, if the value of life derived from a worker with a 40-year life expectancy is $6,000,000 (and the value of a life year is therefore $150,000) the value of the life of an elderly individual with only a 4-year life expectancy would be only $600,000.

This methodology is seriously flawed. It assumes that the value of a life year is independent of the number of life years an individual has left to live. But this approach overlooks the critical role that scarcity plays in determining economic value. Just as individuals value diamonds more than water (because diamonds are scarcer), so too they are likely to value life years more highly when they have fewer life years left. Thus, there is no principled basis for taking the valuation of life year given by a forty-year old and assuming that a seventy-year old would have the same valuation. Instead, the latter's valuation should be expected to be considerably higher.

B. Quality Adjustments

Another inappropriate approach consists in using an approach generally referred to as quality-adjusted life years (QALYs) in performing cost-benefit analyses. The idea behind QALYs is that the lives of sick individuals—asthmatics for example—should be assigned a lower value than the lives of healthy individuals (for comparable life expectancies). For example, the life of an asthmatic might be assigned only half the value of the life of a healthy individual. In the case of the individuals with a 4-year life expectancy discussed above, the value would then be reduced to $300,000—one twentieth the value of the life of a healthy individual with a 40-year life expectancy.

The QALY technique, as generally employed, is incompatible with cost-benefit analysis. Indeed, the measure of benefits in cost-benefit analysis is derived from the aggregation of the individual preferences of all the individuals affected by a policy. Specifically, each individual has a willingness-to-pay to avoid being subjected to some risk, and it is the aggregation of the individual willingnesses to pay that determines what the benefit of the policy would be.

The QALY technique, in contrast, does not seek to determine what individuals in poor health would be willing to pay to avoid a premature death. Instead, it relies heavily on the assessment of third parties, sometimes healthy individuals and medical professionals, of how undesirable a life in poor physical condition is relative to a healthy life.

Such an inquiry suffers from two fundamental flaws. First, it does not construct the valuation by reference to the views of the affected individuals themselves, when it is the preferences of the affected individuals that form the fundamental units on which cost-benefit analysis is based. Second, how much more miserable one might

be in one State rather than another is not responsive to the question of how one's willingness to pay to avoid a premature death varies in the two circumstances. Thus, the rankings provided by the QALY technique typically have no connection to willingnesses to pay, and therefore cannot properly be incorporated into cost-benefit analyses.

IV. CHOICE OF DISCOUNT RATE

For many environmental contaminants, such as carcinogens regulated under section 112 of the Clean Air Act, the harm does not occur contemporaneously with the exposure: there is instead a period of latency. It has been the practice of the Office of Management and Budget (OMB), in its review of agency regulations under Executive Order 12,866, to apply a discount rate in the case of latent harms to reflect the fact that the benefit of regulation would not accrue until the future.

OMB currently uses a discount rate of 7 percent. There is a strong consensus in the economics profession that this rate is too high, and that an appropriate rate would be between 2 and 3 percent. The 7 percent rate used by OMB is set by reference to the pre-tax rate of return on private investments. This rate would be the appropriate one to use if the United States had a closed economy, so that investments for pollution control displaced investments in other activities and, as a result, the government lost tax revenues.

Increasing globalization, however, has led to the integration of capital markets and to the opening of the U.S. economy to foreign investment. In an open economy, the level of taxable investments is unaffected by environmental regulation because no capital projects are displaced; the government therefore does not lose the corresponding tax revenues. Under these conditions, the consumption rate of interest is the appropriate discount rate. This rate is generally taken to be the after-tax rate of return, adjusted for inflation, on relatively risk-free financial instruments such as government bonds—a rate that currently stands in the 2–3 percent range.

The flawed OMB approach leads to a substantial undervaluation of the benefits of environmental regulation. Consider the difference caused by using a 7 percent discount rate as opposed to a 2.5 percent discount rate (the mid-point of the plausible range). For contaminants with a 20 year latency period, the OMB approach undervalues the environmental benefits by a factor of 2.36 (the environmental benefits are 136 percent higher than OMB calculates them to be, so that a benefit that OMB determines to be $100,000,000 is in fact $236,000,000). For a 30-year latency period OMB's approach leads to an undervaluation by a factor of 3.63 (the environmental benefits are 263 percent higher than OMB calculates them to be, so that a benefit that OMB determines to be $100,000,000 is in fact $363,000,000).

If cost-benefit analysis were to become more prevalent as a result of congressional action, this longstanding problem should be corrected. It is noteworthy, moreover, that both the General Accounting Office (GAO) and the Congressional Budget Office (CBO) correctly employ the 2–3 percent rate range rather than the flawed 7 percent rate used by OMB.

V. PROCEDURAL ISSUES

Over the last two decades, cost-benefit analysis has acquired an understandably bad reputation. In its administration of Executive Order 12,866 (and its predecessor, Executive Order 12,291), OMB has attached to the use of cost-benefit analysis procedures that, at least in part, have turned it into an anti-regulatory tool, rather than into a tool to make regulation more rational. Similarly, several of the regulatory reform bills that have been introduced since 1995 contained procedural mechanisms designed to thwart rather than to improve regulation. Let me draw your attention to these pitfalls so that the mistakes of the past (and of the present) can be avoided.

First, the OMB mechanism and the various regulatory reform bills use cost-benefit analysis only in the context of the adoption of a new regulation. In contrast, satisfying a cost-benefit test is not required for the repeal of an existing regulation, the failure to adopt a new regulation, or the failure to make an existing regulation more stringent. The concern for the maximization of social welfare that is implicit in cost-benefit analysis would call for the use of the technique in each of these contexts. The possible losses in social welfare flowing from the repeal of a regulation, the failure to adopt a regulation, or the failure to make a regulation more stringent can be as detrimental—in fact, even more detrimental—than the social welfare losses caused by the adoption of regulations that do not pass a cost-benefit test. There is simply no plausible justification in economic theory (or for that matter in logic) for caring about social welfare losses in one context but not in others.

Second, at times there has been no disclosure (and at other times only limited disclosure) of the communications between interested parties and OMB concerning the

cost-benefit analyses of environmental regulations. It is a core requirement of administrative law, embodied in section 4 of the Administrative Procedure Act, that any submissions to an agency in connection with the promulgation of regulations must be made part of the public record and available for public inspection. The obvious purpose of this requirement is to foster openness and to make judicial review more effective. These goals are seriously compromised when communications concerning cost-benefit are either wholly or partially shielded from the public, as has been the case until now in connection with OMB's administration of Executive Orders 12,866 and 12,291.

Third, some regulatory reform bills allowed for judicial review of the cost-benefit analysis prior to the promulgation of the regulation. This type of challenge runs counter to another well entrenched principle of administrative law—limiting judicial review to "final agency action." This principle, which is codified in section 10(c) of the Administrative Procedure Act, bars piecemeal challenges. The approach of those bills would lead to piecemeal challenges with respect to a single regulation, seriously impairing the efficient use of judicial resources. More importantly, such an approach would paralyze the regulatory process during the pendency of any challenge to a cost-benefit analysis and would have the clear effect of delaying regulation that passes the cost-benefit test and therefore improves social welfare.

Fourth, some regulatory reform bills contained a petition process under which any individual or firm could ask the agency to repeal a regulation that did not satisfy the cost-benefit test. The agency, in turn, was required to respond promptly to such petitions and a denial of the request was reviewable by the courts. Administering a petition process of this sort would have the effect of paralyzing the Environmental Protection Agency and would seriously undermine the goal of rationalizing the regulatory process.

Conclusion

If cost-benefit analysis were to play a larger role under the Clean Air Act, great care must be taken to ensure that it is used fairly, as a tool to make regulation more rational, and not as a tool that is biased against regulation. On the substantive front, it is important to ensure that human lives are not undervalued as a result of the use of various techniques that appear to have currency in some academic sectors. On the procedural front, cost-benefit analysis must be woven into the existing structure of administrative law, without either hiding it from public scrutiny nor subjecting it to legal challenges under rules that are different from those generally provided in the Administrative Procedure Act.

Once again, I am grateful for the invitation to testify at this hearing. I am pleased to answer any questions that you might have.

RESPONSES BY RICHARD REVESZ TO ADDITIONAL QUESTIONS FROM SENATOR BAUCUS

Question 1. In testimony, Professor Graham suggested taking a two-tiered approach to Clean Air Act standards. First, a lenient and flexible cost-benefit analysis, one that does not require high degrees of precision, would be used to set the actual ambient standard. Second, a more stringent cost-benefit analysis would be performed to determine whether or not to apply controls to sources. What views, if any, do you have on such an approach?

Response. That approach is a sensible one. At the level of setting ambient standards, the information on costs and benefits is more speculative. For example, when evaluating an ambient standard, often it will not be clear how the resulting pollution control burden will be allocated among the various sources of pollution. As a result, the estimates on the costs of pollution abatement will have to be based on assumptions about what mix of emission standards will subsequently be adopted to ensure that the ambient standard is met. Given the resulting uncertainties, a flexible approach to cost-benefit analysis that does not require undue precision is probably desirable.

Question 2. Some argue that issues—such as principles of precaution, equity, environmental justice, and individual rights—need to be considered in the development of environmental standards. However, considerations of these issues do not fit neatly into either risk assessment or cost-benefit "tests." How and at what point should these issues be integrated into the standard setting process?

Response. Public policy ought to pay attention to distributional issues, including questions of equity and environmental justice. A cost-benefit analysis that aggregates individual willingnesses to pay can be used to rank various environmental projects. Other social objectives, including distributional concerns, could be used to generate alternative rankings. A tradeoff between the two objectives can generate

the preferred social policy. Alternatively, the cost-benefit inquiry itself can take account of distributional concerns.

With respect to individual rights, the policy prescriptions that emerge from cost-benefit analysis must be constrained by the need to avoid the violation of any constitutional rights, whatever their nature. Finally, because the precautionary principle is poorly specified, the relationship between this principle and cost-benefit analysis is not clear. It is not necessarily the case, however, that the precautionary principle would yield more stringent environmental regulation than cost-benefit analysis.

Question 3. Some have asserted that cost-benefit analysis of environmental and occupational safety regulations puts the benefit side of the equation at an inherent disadvantage. This is because estimates of compliance costs (e.g., dollar cost of installing new technologies at affected industries) are typically easier to produce and ostensibly "harder numbers" than estimates of benefits (e.g., dollar value of increased visibility or averted health harms at low levels of air pollution). The result, as asserted, is that an uneven, "apples and oranges" dynamic is created, leaving the benefit side of a cost-benefit in an inherently weaker position in the context of regulatory, political, and legal proceedings. Please comment further on this issue.

Response. There is an academic literature suggesting that the costs of pollution control tend to get overestimated in cost-benefit analyses. For example, cost-benefit analyses often assume that regulated firms will need to purchase pollution control equipment in order to meet the environmental standards. Over time, however, these firms choose instead to change their production processes, and as a result are able to meet the standards more cheaply. Properly conducted cost-benefit analyses should pay attention to such sources of systematic bias.

RESPONSES BY RICHARD REVESZ TO ADDITIONAL QUESTIONS FROM SENATOR LIEBERMAN

Question 1. What if the costs of controlling emissions from a particular industry would exceed the monetized benefits, but a group of low-income people near these facilities have higher cancer risks compared with those elsewhere. Do you think we should control those sources? If so, how would a cost-benefit test include these kinds of social considerations?

Response. Distributional issues, including environmental justice concerns, ought to be relevant to environmental policy. Under cost-benefit analysis, projects are undertaken based on the aggregate willingness to pay of the beneficiaries. Because the government undertakes large numbers of projects and regulatory initiatives, the losers with respect to one governmental intervention may well become winners with respect to another. But if government regulation produce persistent losers, as may be the case in some environmental justice contexts, redistribution measures should be undertaken.

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ENVIRONMENTAL REGULATION, COST-BENEFIT ANALYSIS, AND THE DISCOUNTING OF HUMAN LIVES

(By Richard L. Revesz, Professor of Law, New York University School of Law)

Introduction

The use of cost-benefit analysis has become commonplace in environmental and other health-and-safety regulation. Such analysis is now mandated by Executive Order 12,866 for all major regulations, [1] and may eventually be required by statute if Congress passes one of the various regulatory reform bills that have been pending for some time. [2] The primary benefit of many important environmental statutes, as determined by the dollar value assigned by cost-benefit analysis, is the human lives that are saved. [3] Thus, in determining whether a particular regulation can be justified on cost-benefit grounds, the central questions revolve around the value assigned to the lives that would be saved by the program. Probably the most vexing problem concerning these valuations has been whether to discount the value of a life saved to account for the fact that the loss does not occur contemporaneously with the exposure to certain contaminants.

With respect to this issue, two opposing camps have developed among regulators, judges, and academics. A similar controversy has arisen in connection with other regulatory programs, [4] as well as with the provision of medical services. [5] Support-

ers of discounting argue that the value of human life must be treated in the same manner as the value of any other benefit or cost: because other benefits and costs are normally discounted to present value when they occur in the future, the value of life should be discounted as well. [6] In contrast, opponents of discounting claim, generally by appeals to notions of ethics and morality, [7] that lives saved in the future are no less valuable than lives saved in the present. As a result, they argue that discounting is inappropriate. [8]

The debate, which is not confined to the United States, [9] has taken on a relatively high profile, including discussion in the popular press [10] For example, the issue played a role in the Senate's scrutiny of the unsuccessful nomination of Judge Douglas Ginsburg to the Supreme Court of the United States in 1987, [11] and attracted the attention of Vice President Albert Gore during the 1992 Presidential campaign. [12]

The discussion of the propriety of discounting human lives often conflates two different sets of problems. [13] In the first, the benefits will not accrue until the future because the harm has a latency period. For example, an individual exposed to a carcinogen faces an increased probability of dying at some point in the future, perhaps 20 or 30 years later. In the second, the benefits of controls accrue primarily to future generations. Climate change caused by the presence of anthropogenic gases in the atmosphere is a prominent example of this phenomenon.

The question of how to value lives threatened by latent harms was starkly posed in a regulatory proceeding that took place in the late 1980's in connection with a partial ban on the use of asbestos promulgated by the Environmental Protection Agency (EPA). [14] The Office of Management and Budget (OMB), which is responsible for reviewing regulations to ensure their consistency with cost-benefit principles, [15] strongly urged discounting the value of human lives over the period of latency of the harm; under its then-existing policy of discounting environmental benefits at a 10 percent discount rate, the value of saving a life would have been reduced to only about $22,000. [16] EPA withstood OMB's pressure and published final regulations that essentially rejected the concept of discounting. The EPA's regulation was invalidated by the Fifth Circuit, partly for this reason. [17]

A recent article by Lisa Heinzerling shows how much rides on whether the value of human lives is discounted over a latency period. [18] She shows that many environmental and health-and-safety regulations promulgated since the 1970's have acceptable cost-benefit ratios if the value of lives is not discounted, but fail cost-benefit analysis if those values are discounted. [19]

Discounting issues play an even more critical role in connection with harms to future generations, particularly with respect to the effects of climate change. Because of the long lag until many of the harmful effects of excessive anthropogenic gases in the atmosphere are felt, how much our society is willing to spend on measures to prevent climate change may well depend on how the question of discounting is resolved. [20]

Opponents of discounting adduce vivid statistics to illustrate what is at stake. For example, Derek Parfit notes: "At a discount rate of five per cent, one death next year counts for more than a billion deaths in 500 years." [21] Even economists who do not oppose discounting acknowledge its striking effects: "When time horizons are very long, all benefits are discounted to zero using any positive discount rate, so that a death prevented in the distant future is worth nothing at the present time." [22]

This Article seeks to shed light on what has become a shrill and unproductive debate. The polar positions on both the latency and future generations issues are analytically unsound and overlook important components of both problems. Moreover, the latent harm and future generation situations are analytically distinct: what one concludes with respect to discounting in one context says little about the appropriate treatment of discounting in the other.

Part I addresses the problem of latent harms. Because there are essentially no empirical studies of the value of lives threatened by latent harms, regulatory analyses must adapt valuations derived from threats of instantaneous death in workplace settings. This Article argues that it is necessary to discount this value, to reflect that the years lost occur later in a person's lifetime. It also argues, however, that such discounting must be accompanied by countervailing upward adjustments, to account for the involuntary nature of exposure to environmental carcinogens, the dread such exposure causes, and the higher income levels of the victims. By not performing these adjustments, OMB may be undervaluing lives by as much as a factor of six, or even more for particularly long latency periods. Correcting this undervaluation, as this Article urges, could have an important impact on the regulatory process by allowing more stringent regulations to satisfy the requirements of cost-benefit analysis.

Part II deals with harms to future generations. It shows that the use of discounting in that case is ethically unjustified. As a result, it argues that discounting approaches should not replace the principle of sustainable development, which is used in the major international environmental law agreements to measure our obligations to future generations. The discussion shows, however, that the principle of sustainable development is also problematic, and sets forth the principal elements of an attractive theory of intergenerational obligations. The practical implications can be enormous: the rejection of discounting may lead to a far more stringent response to environmental problems, such as climate change, that have long time horizons.

The Article underscores the extent to which discounting raises analytically distinct issues in the cases of latent harms and harms to future generations, even though these two scenarios have generally been treated as manifestations of the same problem. [23] In the case of latent harms, one needs to make intra-personal, intertemporal comparisons of utility, whereas in the case of harms to future generations one needs to define a metric against which to compare the utilities of individuals living in different generations. The case of latent harms gives rise to a problem that is primarily technocratic: determining how an individual trades off the utility derived from consuming resources at different times in her life. In contrast, the case of harms to future generations raise a difficult ethical problem. It is therefore not surprising that the appropriateness of discounting would be resolved differently in the two contexts.

The Article does not address the role that cost-benefit analysis should play in environmental regulation—a subject that has spawned a large academic literature. [24] Rather, its goal is more targeted. It assumes, consistent with current practice, [25] that an important set of environmental and health-and-safety regulations will be evaluated under principles of cost-benefit analysis, and that human lives will be valued as part of this analysis. Given these practices, it seeks to determine the best way to account for the fact that certain losses do not occur contemporaneously with the exposure to a contaminant.

A central goal of this Article is to move the regulatory process to wards a more thoughtful valuation of human lives threatened by environ mental carcinogens, and away from OMB's deeply flawed technique of taking valuations from the workplace setting and reducing them by an inflated discount rate. [26] The Article also seeks to move the discussion of how to treat future generations beyond a focus on discounting, which is unlikely to provide an ethically defensible account of our obligations to future generations.

I. LATENT HARMS

The discussion begins in Section A by reviewing the central role that the debate over discounting played in the Corrosion Proof Fittings case and the extent to which, despite the court's resolution in that case, the issue remains unsettled in the public policy arena. Section B explains that the valuations of human life in the economics literature have been conducted almost exclusively in the context of industrial accidents, where workers face a probability of instantaneous death. In contrast, as a result of understandable methodological complications, there have been essentially no valuations of risks to life with a long latency period, such as those posed by environmental carcinogens. Thus, it is necessary to construct a second-best valuation of a life threatened by a contaminant with a latency period, using as a starting point the valuations from the existing empirical studies on instantaneous deaths.

Section C begins the task of constructing a second-best valuation, relying on temporal models that describe the value of life by reference to a stream of utilities that individuals receive if they are alive in particular time periods. When an individual faces a threat to life that manifests it self only after a latency period, she loses fewer life-years than when the threat is instantaneous. Moreover, on average, the loss of life-years occurs further into the future. Downward adjustments to account for these two factors are therefore appropriate.

Section D examines the plausibility of the assumptions underlying the temporal models explored in Section C. It also shows that the discounting of future utilities is conceptually different from the discounting of money flows.

Section E turns its attention to three important upward adjustments that need to be made when extrapolating from the case of instantaneous deaths to that of carcinogenic harms. These adjustments are necessary as a result of the relationship between an individual's income and the value that she places on life, the involuntary nature of exposure to environmental carcinogens, and the dread people suffer from carcinogenic risk.

Section F focuses on the choice of an appropriate discount rate. It shows that the emerging consensus in the economics literature calls for the use of a rate of 3 percent or less and takes issue with OMB's policy of prescribing a 7 percent rate.

Section G estimates the undervaluation of life that results from OMB's approach of taking valuations from the workplace setting and, without further adjustment, mechanically reducing them by an inflated discount rate. Over a 20 year latency period, the OMB approach can lead to an underestimation by a factor of about six, with a factor of about two being attributable to the choice of discount rate.

Section H argues that discounting the value of life in the context of latent harms does not pose significant moral or ethical dilemmas that are distinct from those raised by cost-benefit analysis in general and the valuation of human life in particular. It is simply one defensible adjustment in the process of constructing a second-best valuation, using workplace valuations as a starting point. Discounting, however, cannot be the only such adjustment.

Before proceeding further, it is useful to underscore that Part I focuses on harms that an individual suffers as a result of an earlier exposure to an environmental contaminant. [27] The term "latent" could be used to describe other phenomena as well: for example one might think that an environmental exposure producing a harm to future generations gives rise to a latent harm as well. As used throughout this Article, however, the term "latent" is used to describe only situations in which the exposure and the harm accrue to the same individual.

A. The Debate Over Discounting

The appropriateness of discounting the value of human lives first received sustained attention in the regulatory proceeding that led to EPA's partial ban on the manufacture, importation, and processing of asbestos under the Toxic Substances Control Act (TSCA), and the challenge to this regulation in Corrosion Proof Fittings v. EPA. [28] The question was highly controversial even before EPA's publication of the notice of proposed rulemaking in 1986. [29] As required by Executive Order 12,291 (the Reagan Administration's predecessor of Executive Order 12,866), [30] EPA submitted the draft rule to OMB for review before its publication in the Federal Register. In a March 1985 letter to A. James Barnes, EPA's acting Deputy Administrator, OMB raised questions about whether the benefits of the rule exceeded its costs. [31] In performing a cost-benefit analysis, OMB used a value per cancer case avoided of $1 million and discounted this amount at a rate of 4 percent for the length of the latency period. [32](At the time, an OMB guidance document provided for discounting of costs and benefits at a rate of 10 percent, [33] but OMB instead used the rate contained in EPA's guidance document on cost-benefit analysis.) [34]

The following month, the propriety of discounting the value of human lives became an issue in connection with Barnes's Senate confirmation hearings:

I have a great deal of ethical difficulty with a concept of applying a discount factor to human life. The lives of my three children are worth every bit as much to me 10 years from now as they are now. I personally reject that notion. I have talked to [EPA Administrator] Lee Thomas about it; I know that it is not one that finds favor with him. [35]

In October 1985, a subcommittee of the U.S. House of Representatives chastised OMB for its insistence on discounting the value of human lives. [36] It noted that discounting at OMB's 10 percent discount rate over a 40 year latency period would reduce the $1 million value per life saved to just over $22,000. [37] Thus, on cost-benefit terms, one could not justify a current expenditure of over $22,000 to save a life 40 years in the future. Even at a 4 percent discount rate, the $1 million value of life would be reduced to about $208,000. [38]

The subcommittee referred to the testimony of Don Clay, Director of EPA's Office of Toxic Substances, that EPA "never had used discounting over the latency period of a chronic hazard," and that, by reducing the value of benefits to such an extent, OMB's approach would prevent EPA from regulating any carcinogen with a long latency period. [39] The subcommittee further reported that Clay "personally opposed the discounting of lives in the asbestos case on ethical grounds." [40] It concluded that OMB's position with respect to the discounting of the value of life was "simply an outrage" and urged EPA to "reject the use of discounting over the latency period of diseases caused by chronic hazards." [41]

EPA published the proposed rule on the asbestos ban in January 1986. [42] The proposal did not quantify the value of life or undertake any discounting of this value over the length of the latency period. [43] EPA took a different approach, however, when it promulgated the final rule in July 1989. [44] It assigned a value to human lives, but discounted it at a rate of 3 percent from the time of the promulgation of the regulation until the time of the exposure to the carcinogen. [45]

The use of asbestos products does not necessarily result in immediate exposure; instead, exposure occurs when the product containing the asbestos begins to disintegrate. For example, some exposures occur when asbestos fibers are released into the air from the weathering of air conditioning products. [46] Exposure is the first step of a process that might later lead to the incidence of cancer and subsequently to a death from cancer. EPA did not discount the value of human life from the time of exposure until the carcinogenic death, as OMB had urged, or even until the first manifestation of cancer.

In its response to comments accompanying the final rule, EPA at tempted to defend this decision. EPA noted that comments had been written on both sides of the discounting issue:

Some commenters argued that EPA, in the proposal, improperly failed to discount benefits to be derived from the rule, and in support of documents for a final rule, only discounted benefits until the time of the exposure that results in the cancer rather than until the occurrence of the disease. Other commenters argued that EPA should not discount benefits, stating that discounting the benefit of saving human life is inappropriate methodology for this rulemaking. [47]

EPA's response revealed a degree of ambiguity on this question and provided at best a lukewarm defense of its course of action. It stated:

Arguments can be made that estimating benefits without discounting is preferable in cases like this one where the primary benefits derived is [sic] the avoidance of human cancer cases. However, arguments also can be articulated supporting the discounting of benefits. [48]

EPA was more categorical in defending its view that if discounting was appropriate at all, it was appropriate only until the time of exposure:

Since the benefit of a regulation to control a hazardous substance occurs at the time of the reduced exposure, EPA has concluded that the appropriate period over which to discount is until the time of exposure reduction. This approach was used in this case after extensive review of applicable literature and an examination of the inherent biases and features of other approaches. [49]

This position has an important corollary for environmental problems in which the regulation leads to an immediate decrease in the exposure of individuals as is the case, for example, with airborne air pollutants. For such pollutants, no discounting of the benefits of the regulation would be performed under EPA's approach, except perhaps for discounting from the time of the preparation of the cost-benefit analysis to the implementation of the regulation.

Though EPA's explanation is not a model of clarity, one can surmise that its approach was not to discount for the period between the exposure and the death, when the harm was latent. Instead, the discounting that was performed affected only the period before the harm became latent.

In October 1991, the Fifth Circuit vacated the regulation and remanded in Corrosion Proof Fittings v. EPA, [50] in part because of EPA's treatment of the discounting issue. The Fifth Circuit took the position that discounting was necessary in order to provide for a fair comparison of costs and benefits accruing at different times:

Although various commentators dispute whether it ever is appropriate to discount benefits when they are measured in human lives, we note that it would skew the results to discount only costs without according similar treatment to the benefits side of the equation. . . . Because the EPA must discount costs to perform its evaluations properly, the EPA also should discount benefits to preserve an apples-to-apples comparison, even if this entails discounting benefits of a non-monetary nature. [51]

The Fifth Circuit went on to hold that EPA had used an improper period for discounting, and that the value of human life should have been discounted to the time of injury. [52] It noted:

The EPA's approach implicitly assumes that the day on which the risk of injury occurs is the same day the injury actually occurs. Such an approach might be appropriate when the exposure and injury are one and the same, such as when a person is exposed to an immediately fatal poison, but is inappropriate for discounting toxins in which exposure often is followed by a substantial lag time before manifestation of injuries. [53]

The court did not specify, however, whether it considered the injury to be the first manifestation of cancer or the death from cancer. The detection of carcinogenic cells is a serious injury, but if death does not follow it is not clear why it would be appropriate to attach to this injury the full value of life, rather than the value of the resulting morbidity. [54]

Finally, the Fifth Circuit upheld EPA's choice of a 3 percent discount rate. It implicitly assumed that the correct discount rate was the real rate of interest (the nominal rate of interest minus the rate of inflation) and stated that, historically, this rate has fluctuated between 2 percent and 4 percent. [55]

Despite the court's holding, the question of discounting the value of human life has continued to be controversial. For example, the Senate Report accompanying the Comprehensive Regulatory Reform Act of 1995, [56] which would require the use of cost-benefit analysis in regulatory proceedings, [57] contains a statement by Senator Leahy railing against such discounting:

Cost/benefit analysis assumes that benefits that occur in the future have very little value. After determining the value of human life, cost/benefit analysis applies a "discount rate" to benefits that will occur in the future. Benefits of the lives saved in the future by a regulation are reduced by 6–7 percent per year. . . . This business evaluation tool does not make sense when applied to the protection of human life. [58]

The regulatory debate over the appropriateness of discounting of human lives, stated in conclusory terms and virtually devoid of any sustained analysis, fails to shed light on the important issues underlying this question. [59] After providing a brief overview of the economic approach to valuing human life, the remainder of Part I seeks to fill this void.

B. Valuations of Human Life

Since the 1970's, willingness-to-pay studies have become the standard economic technique for placing a value on human life. [60] By far the most common method for performing such valuations focuses on the choices that workers make in accepting risky jobs. [61] The approach begins by defining sets of jobs that require comparable skills and offer comparable non-monetary amenities, except that one exposes the worker to a higher risk than the other. [62] Presumably, a rational worker would not accept the riskier job unless she obtained sufficient compensation for the additional risk. The resulting wage differential is the compensation that the worker obtains for the additional probability of death that she faces as a result of having taken the riskier job. [63] An extrapolation, consisting of dividing the wage differential by the additional probability of death, is then per formed to determine the value of life. [64]

Willingness-to-pay studies of the value of human life have been conducted almost exclusively in the context of industrial accidents, where the worker faces a risk of being either fatally injured by a piece of machinery and dying instantaneously, or surviving unscathed. [65] In any time period, there is a probability that a fatal accident will occur. This probability is ascertained from industrial safety statistics. [66]

One could use the same approach to determine the willingness-to-pay to be free from risks with long latency periods. [67] As long as workers understood the additional probability of, say, dying of cancer from a riskier job, and knew the length of latency period, they could figure out how much additional compensation to demand in order to accept the job with the higher risk. From this wage differential, one would extrapolate to determine the value of the life. The fact that the harm would accrue only in the future would be reflected in the wage differential. For example, other things being equal, an individual with a comparatively high discount rate would demand a comparatively low wage differential. We would then have measured exactly what we wanted to see, and there would be no need to perform any discounting.

It is likely that such studies have not been conducted for three principal reasons. First, the industrial statistics on deaths resulting from la tent harms are not as extensive as those for instantaneous accidents. The Federal Government became extensively involved in the regulation of workplace and environmental safety only in the 1970's (and prior State efforts in these areas were relatively modest). [68] For example, if the Federal Government began to compile statistics on the risk of various work place settings in the mid-1970's, it would have immediately had a data set on instantaneous accidents. In contrast, for carcinogenic risks with a 20-year latency period, comparable statistics on such risks would not be available until the mid-1990's, unless retrospective studies could be per formed. Moreover, while accidents on the job are relatively easy to track, statistics on mortalities associated with latent harms require much more difficult tracking of the health status of individuals after they leave their jobs. Further, while the cause of on-the-job accidents typically is relatively easy to identify, the causal link between occupational exposure and future harms from carcinogens can be difficult to establish.

Second, in order for willingness-to-pay studies to yield meaningful results, individuals must be able to properly understand the nature of the risk; otherwise, they cannot determine what sum of money properly compensates them for the risk. Some commentators doubt that our cognitive capacities are sufficiently developed to perform such valuations in the case of future harms. [69]

Third, this problem is compounded by the fact that exposure to carcinogens may have a differential impact depending on an individual's characteristics, including,

for example, whether she smokes. In order to decide how to respond to a wage premium, individuals would need to understand not only the "pure" carcinogenic risk of the job, but also the magnitude of any synergistic interactions that might result from such characteristics.

In summary, the task of directly performing a willingness-to-pay study of the value of life in the case of latent harms is fraught with difficulties, perhaps insurmountable ones. Instead, to obtain such a valuation, resort to a second-best approach is necessary.

C. Discounting as a Second-Best Approach

As a result of the difficulty of obtaining a direct willingness-to-pay measure of the value of a life threatened by a latent carcinogenic harm, economists have devoted considerable attention to defining a relation ship between the value of a life lost today and the value of a life lost years from now. Such temporal models, also known as life-cycle models, study the distribution of an individual's utility throughout her life. [70]

The discussion that follows focuses, for illustrative purposes, on three different valuations: first, the life of a 40-year old that is lost today, for example, from an industrial accident; second, the life of a 60-year old, also lost today; and third, the life of an individual who is currently 40 years old but dies in 20 years as a result of exposure today to a carcinogen with a 20-year latency period. [71] For this discussion, $V_{j,k}$ denotes the value attached to the life of an individual exposed to a harm at age *j* who dies at age *k*. Thus, the values of the three lives described above can be expressed as $V_{40,40}$, $V_{60,60}$, and $V_{40,60}$, respectively. To keep the discussion simple, it assumes that these individuals, if not exposed to the industrial or carcinogenic risk, would die of natural causes at age 80. [72]

The three valuations differ in two important ways. [73] First, the 40-year old dying immediately loses 40 years of life whereas the 60-year old dying immediately and the 40-year old dying in 20 years lose only 20 years of life. [74] Second, the individual exposed to the carcinogen does not lose these 20 years of life immediately, but 20 years later. [75] Let u_l denote the utility that an individual derives in year *l* from living that year. So, for example, for the 40-year old exposed today to the latent harm, u_{60} is the utility that the individual would derive in 20 years from living in the year following her sixtieth birthday. In contrast, for the 60-year old killed today in an industrial accident, u_{60} is the utility that the individual would have derived this year if the accident had not occurred.

If these utilities were simply monetary payments as opposed to the well-being that comes from living, they could easily be compared with one another by discounting the future stream of benefits by a means of a discount rate. Discounting reflects the fact that it is more desirable to get a payment sooner rather than later. It is important to stress that this preference is not a function of the existence of inflation. In comparing monetary flows occurring at different times, the effects of inflation can be adjusted by converting all amounts to constant dollars. But even in an inflation-free world, it is best to get a given amount of money as soon as possible. Having the money sooner gives one the option of either spending it immediately or saving it for later, whereas getting it later (absent borrowing) rules out immediate spending. The rate used to discount amounts in constant dollars is typically known as a "real" discount rate. [76]

Given a discount rate of *r*, the present value of a payment P that is paid *t* years from now is $[1/(1 + r)^t]P$. [77] I am not suggesting at this point that discounting to present value the utility that an individual derives from living for a year is equivalent to discounting a monetary payment, and will return to this issue later. [78] Instead, I am showing the relation ship among the values of the three different lives if such discounting were appropriate.

Then,

$$V_{40,40} = u_{40} + [1/(1 + r)]u_{41} + \ldots + [1/(1 + r)^{38}]u_{78} + [1/(1 + r)^{39}]u_{79}$$

The loss for the 40-year old killed by the industrial accident is the utility of living in the year following the individual's fortieth birthday, plus the utility of living 1 year later discounted for 1 year, plus the utilities of living in all subsequent years until age 80 (when the individual would have died anyway), with each utility discounted for the number of years elapsed since the present.

In turn,

$$V_{60,60} = u_{60} + [1/(1 + r)]u_{61} > + \ldots + [1/(1 + r)^{18}]u_{78} + [1/(1 + r)^{19}]u_{79}$$

Here, the loss takes the same form, except that the first year of loss of utility is the year following the individual's sixtieth birthday.

Finally,

$$V_{40,60} = [1/(1+r)^{20}]u_{60} + [1/(1 + r)^{21}]u_{61} + \ldots + [1/(1 + r)^{38}]u_{78} + [1/(1 + r)^{39}]u_{79}$$

Only years following the individual's sixtieth birthday are lost, and these losses are discounted by the number of years from the present.

The relationship between $V_{[60,60]}$ and $V_{[40,60]}$ should now become apparent. The latter value is simply the former discounted by 20 years. [79] In other words, both individuals lose the same years of their lives—those following their sixtieth birthdays—but the latter individual loses them 20 years later than the former. Thus,

$$V_{40,60} = [1/(1+r)^{20}]V_{60,60}$$

Under this approach, the value that should be attached to the life of a 40-year old who is exposed to a carcinogen with a 20 year latency period and who dies at age 60 is equal to the value of the life of a 60-year old who dies instantaneously in an industrial accident, with the latter value discounted for the 20 years that elapse before the carcinogenic victim dies.

So far, in fact, the discussion suggests that the OMB approach actually overestimates the value of the loss resulting from exposure to latent risks. The OMB procedure takes $V_{40,40}$ and discounts it back to present value to account for the latency period. [80] In fact, the correct approach would be to discount $V_{60,60}$ instead, [81] which is lower than $V_{40,40}$ because of the 20 fewer years of life loss. [82] As explained later, however, this overvaluation is outweighed by the substantial undervaluation that results from other elements of OMB's approach. [83]

D. Plausibility of the Model

The model presented in the previous section relies on two important assumptions. First, it assumes that an individual's utility function can be expressed as a sum of utilities over the various periods comprising one's lifetime. Thus, one's enjoyment of life in one period is not affected by the resources available for consumption in prior periods, [84] but only by the resources in that period. [85] Under the model, an individual's utility in one period is not affected by the resources available for consumption in prior periods. [86] So, for example, whether an individual was able to afford a quality education in a prior period does not affect the utility that she derives from a given level of consumption in subsequent periods. This assumption is clearly debatable. Indeed, John Broome, in a related con text, terms the assumption "dubious," [87] though he acknowledges that it is commonly made in economic analysis. [88]

Moreover, an individual facing death from cancer may focus on the fact of the death and on its cause, without paying particular attention to the death's timing. One's willingness-to-pay to avoid the risk may then be relatively unaffected by the length of the latency period. A number of studies show that individuals of different ages exhibit different willingnesses-to-pay to avoid instantaneous deaths, suggesting, consistent with the model, that their valuations are indeed affected by the number of life-years that they would lose. [89] It is possible, however, that such behavior would not extend to carcinogenic risks as a result of the dread associated with such deaths. [90] As a result of the paucity of studies of the willingness-to-pay to avoid carcinogenic risks, [91] it is not possible to make empirically grounded claims concerning this hypothesis.

Second, the model uses a constant discount rate. [92] So, for example, the same rate would be used to discount the utility of living 20 years in the future as would be used to discount the utility of living next year. As Donald Shepard and Richard Zeckhauser put it, the model assumes that "an individual's utility over lifespans of different length can be represented as a weighted sum of period utilities, the weights declining geometrically with time." [93] Shepard and Zeckhauser label this assumption "heroic." [94]

If, for example, I did not currently value at all the utility of living beyond the year 2010, I would be applying an infinite discount rate to the utilities that I would derive if in fact I were alive beyond that year. The present discounted value of those utilities would be zero. There is no mechanism by which I could transfer any life-years beyond the year 2010 to someone with a lower discount rate, in return for a higher present utility. In contrast, in the case of financial flows, if I undervalued relative to the market the stream of payments that I would receive on my Treasury bond after the year 2010, I could increase my utility by selling that stream of payments at the market price. [95]

There is little attempt in the literature to validate the constant discounting feature of the model through experiment or observation. [96] One study of the implicit discount rates reflected in individuals' contin gent valuation of the disutilities of various illnesses led the authors to question whether the conventional discounting model properly describes individual preferences. [97]

These problems with the assumptions underlying the temporal models for the valuation of lives threatened by environmental carcinogens should not lead to the conclusion that the models are inappropriate. At present, such models are the state-of-the-art in economic analysis. It is therefore proper to continue to use them, ab-

sent a further refinement or an empirical falsification. But as the regulatory process seeks to construct appropriate second-best valuations for lives threatened by environmental carcinogens, it must pay further attention to the plausibility of the assumptions underlying temporal models.

E. Necessary Adjustments

It is time now to scrutinize with more care some of the assumptions made implicitly in the model described in Part I.C. Such scrutiny reveals, for several reasons, that one cannot simply take an estimate of the value of life from an industrial accident (whether $V_{[40,40]}$ or $V_{[60,60]}$), [98] discount it, and obtain a plausible estimate of the value of life from exposure to an environmental carcinogen with a latency period. [99] Many adjustments need to be made for the estimate to be at all meaningful. These adjustments all lead to assigning a higher value to the life lost.

This section examines the principal adjustments that need to be per formed. It focuses primarily on differences between the valuations for instantaneous and latent harms that have been the subject of empirical examination.

1. Impact of Income on the Valuations of Life.—In the temporal model presented in Part I.C, the utility that an individual derives in a particular year is a function of the level of resources available for consumption that year. Economists have estimated that the elasticity of the value of life with respect to earnings (the percentage change in the value of life for a 1-percent change in earnings) is approximately one. Thus, for example, a 10 percent increase in income would lead to a 10 percent increase in the value of life. [100] The impact of income on the valuation of life calls into question several of the implicit assumptions made in Part I.C.

a. Increases in Income Over Time.—That model assumes implicitly that the valuation of a particular year of life, say the year following one's 65th birthday, is independent of the age of the individual making the valuation. Thus, for example, u_{65}, the utility of living in the year following one's 65th birthday, is the same for both a 40-year old and a sixty-year old. The only difference related to the valuation is that the 40-year old discounts this utility for the 25 years that it will take until this utility is realized, whereas the sixty-year old discounts the utility for only 5 years.

A correction needs to be made, however, if income adjusted for inflation rises over time. In comparing $V_{[40,60]}$ with $V_{[60,60]}$, one must account for the fact that by the time the 40-year old is sixty, her income, in real terms, will be higher than the sixty-year old's income is today.

If income rises in real terms over time, the relationship between $V_{[40,60]}$ and $V_{[60,60]}$ becomes different than that posited in Part I.C. [101] Let *g* be the yearly increase in the individual's real income. Then,

$V_{[40,60]} = [(1 + g)/(1 + r)][^{20}]V_{[60,60]}$

Thus, $V_{[60,60]}$ now needs to be subjected to two adjustments. [102] First, it is increased by a factor of $(1 + g)[^{20}]$ to account for the fact that the years of lost life will occur 20 years later for the 40-year old, and that for each of the years of life lost, the utility lost 20 years from now to the individual who is currently 40 years old will be $(1 + g)[_{20}]$ greater than for the individual who is currently 60 years old. Second, it is decreased by a factor of $[1/(1+r)][_{20}]$ to discount to present value the utilities that the current 40-year old would enjoy 20 years later. To a first approximation, [103] the relationship between $V_{[40,60]}$ and $V_{[60,60]}$ simplifies as follows:

$V_{[40,60]} = [1/(1 + r—g)][^{20}]V_{[60,60]}$

For example, if the real discount rate is 3 percent but income is rising at a yearly rate of 1 percent in real terms, then the effective rate at which $V_{[60,60]}$ would be discounted to arrive at $V_{[40,60]}$ would be 2 percent. Moreover, if *r* and *g* were equal, then $V_{[40,60]}$ and $V_{[60,60]}$ would be equal as well. [104] The increase in the valuation of $V_{[40,60]}$ to account for rising real incomes would exactly counteract the decrease resulting from the time lag in the enjoyment of utilities.

Table I presents the changes between 1982 and 1996 in mean and median incomes for workers 15 years and over. The figures are presented in constant 1996 dollars. [105]

Table I: Median and Mean Earnings of Workers of 15 Years Old and Over

(in constant 1996 dollars)

	Median Earnings	Mean Earnings
1996	20,716	27,366
1995	20,541	26,870
1994	19,858	26,668
1993	19,566	26,107

Table I: Median and Mean Earnings of Workers of 15 Years Old and Over—Continued
(in constant 1996 dollars)

	Median Earnings	Mean Earnings
1992	19,521	25,124
1991	19,752	25,110
1990	20,092	25,446
1989	20,667	26,293
1988	20,475	25,755
1987	20,182	25,401
1986	19,564	25,078
1985	18,787	24,169
1984	18,366	23,428
1983	18,275	23,064
1982	18,135	22,760

The table reveals that median and mean income grew at compound rates of 0.95 percent and 1.01 percent per year, respectively. [106]

b. Age-Dependent Nature of the Valuation.—A different issue is raised by life-cycle changes in levels of income. For example, Donald Shepard and Richard Zeckhauser analyze the valuations of a typical individual who enters the work force at age 20, sees steadily rising income up to age 50, then experiences a small decrease in income until age 65, and loses all income as a result of retirement at age 65. [107] The economics literature assumes that people value their lives as a function of their current income (and resulting consumption), not on the basis of projections of future income. [108] Richard Zeckhauser has labeled this phenomenon as "temporal myopia." [109]

Shifts in an individual's income across time would not make a difference to the valuations of life if borrowing were available to equalize the amounts available for consumption. Typically, however, there are serious roadblocks to borrowing based on the expectation of higher incomes in the future. [110] And, to the extent that such borrowing is possible, for example through credit cards, the interest rates are prohibitively high.

Shepard and Zeckhauser calculate the impact of age on a person's valuation of life for two different scenarios, to which they attach "Robinson Crusoe" and "Perfect Markets" labels. In both cases, the individual supports her consumption from her own income and wealth, and has no heirs or dependents. In the Perfect Markets scenario, the individual can borrow in the capital markets, in order to support a higher level of consumption earlier in life, and can purchase annuities to insure against variability in her lifespan. In contrast, in the Robinson Crusoe scenario, access to these two markets is unavailable. [111]

The authors show that in the Robinson Crusoe model an individual's valuation of life reaches its peak at age 40. A 40-year old values her life 2.5 times as highly as a 20 year old (that is, returning to the notation previously used, $V[_{40,40}] = 2.5V[_{20,20}]$). At first glance, this result might appear counterintuitive. After all, the 20-year old loses 20 more years of life than the 40-year old. The reason that the 40-year old's valuation is higher, however, is that her income is more than three times higher, and this effect more than counteracts the shorter remaining life. [112]

In turn, in the Robinson Crusoe world, the 40-year old values her life almost twice as highly as a sixty-year old ($V[_{40,40}] = 1.98V[_{60,60}]$). [113] Two different effects are at play here. Most obviously, the sixty-year old has fewer years to live. But another factor is depressing the sixty-year old's valuation of her life. Beyond age 40, income continues to rise until age 50, but consumption begins to fall. The reason is that at age 40, the individual begins to save for retirement and therefore has fewer resources available for current consumption. Indeed, even though income at age 60 is comparable to income at age 40, consumption is about 25 percent lower. [114]

The situation is more straightforward under the Perfect Markets scenario. There, the valuation of life is highest at age 20, and then falls continuously through the life cycle. In this model, the 40-year old's valuation is about two-thirds higher than that of the sixty-year old. [115] Here, the difference between $V[_{40,40}]$ and $V[_{60,60}]$ is attributable exclusively to the different number of years of remaining life.

To the extent that the assumptions underlying the Robinson Crusoe model are at least partly realistic, [116] one needs to worry about the procedure described in Part I.C in which the sixty-year old's willingness-to-pay to avoid an immediate death, $V[_{60,60}]$, was used as a proxy (and then discounted) for a 40-year old's willingness to pay to avoid a death 20 years later, $V[_{40,60}]$. Given the levels of income and savings analyzed by Shepard and Zeckhauser, using $V[_{60,60}]$ as a proxy for $V[_{40,60}]$, as

was done in Section I.B, will result in an undervaluation of the willingness to pay to avoid death of about 25 percent (as a result of the lower level of consumption at age 60). [117]

This undervaluation, however, may have decreased over time. Shepard and Zeckhauser relied on data from the late 1970's. [118] Certain legal changes since that decade, particularly the end of mandatory retirement and the strengthening of protections against age discrimination, are likely to have affected the impact of age on income. In particular, it is possible that the peak income is received later in life and that the assumption that individuals receive no income after the age of sixty-five is now unrealistic. These changes would result in increasing the ratio of the sixty-year old's consumption relative to that of the 40-year old and thereby diminishing the difference in the valuations of $V_{[40,40]}$ and $V_{[60,60]}$ in a Robinson Crusoe economy.

In summary, the discussion in this subsection is presented only to illustrate the underlying methodological issues that must be resolved to obtain a plausible estimate of the value of life. More work needs to be done to determine the plausibility of the Robinson Crusoe model and the effects of changes in workplace patterns and legal protections since the 1970's.

c. Distribution of Income Across Occupations.—Individuals who take risky jobs generally have lower-than-average income. [119] Thus, there is a problem in extrapolating from the willingness-to-pay studies conducted in high-risk occupations to the broader population affected by environ mental carcinogens.

One threshold issue concerns the definition of the population affected by the different environmental programs. In principle, for every environmental regulation, one could attempt to determine the identity, age profiles, and economic characteristics of the affected population. One could then construct program-specific valuations of life that took into account the distribution of ages and incomes of the affected population, as well as of the latency period of the carcinogen subject to the regulation.

There are good reasons why one might not want to undertake such an evaluation. First, the informational requirements are likely to be daunting. For every environmental program, in addition to estimating the number of affected individuals, one would need to determine their demographic and economic characteristics. [120]

Second, an effect of particularized valuations based on levels of in come would be to justify, on cost-benefit grounds, more stringent regulation when the affected population is wealthier. Such a policy would be inconsistent with the central tenet of the increasingly influential environ mental justice movement, which calls for environmental regulation to be no less (if not more) responsive to the needs of communities that are disproportionately poor, or disproportionately populated by people of color than to the needs of wealthy, white communities. [121]

As a result, it is reasonable for EPA to use uniform valuations of life across environmental programs. These valuations would be based on representative characteristics of the population of the United States. [122] Thus, to the extent that the subjects of the empirical studies involving industrial accidents have relatively low incomes, an upward adjustment in their valuations of life must be performed before translating these figures to the environmental context.

The U.S. Census provides median and mean earnings for all workers and for various occupational categories. [123] The category including operators, fabricators, and laborers might be a good proxy for workers in risky occupations who are the subjects of empirical studies concerning the value of life. In 1996, the median and mean earnings of all workers 15 years of age and over were $20,716 and $27,366, respectively. [124] The corresponding figures for operators, fabricators, and laborers were $16,883 and $19,981. [125] Thus, the overall median earning is 22.7 percent higher than the median for workers in risky occupations, and the overall mean is 36.8 percent higher.

2. Involuntary Nature of the Harm

a. Comparative Valuations of Voluntary and Involuntary Risks.—There is an extensive literature suggesting that individuals assign greater value to avoiding risks that are thrust upon them involuntarily than risks that they incur voluntarily. [126] As Richard Zeckhauser points out, "this tendency would introduce a downward bias in the implicit life valuations of those who voluntarily assume risks." [127]

The risk assumed by individuals who take risky jobs and subject themselves to a non-trivial possibility of industrial accidents is generally thought of as a risk assumed voluntarily. [128] In contrast, the risk of exposure to environmental carcinogens, for example, as a result of toxic air pollution, is generally thought of as involuntary. [129]

As a result, there will be a systematic undervaluation if one takes the willingness-to-pay to avoid voluntary harms and imports that figure into the context of environ-

mental regulation. Determining the extent of the undervaluation, however, is complicated.

The economics profession strongly favors "revealed preference" valuations, under which the value assigned to a good can be observed through a market transaction. Willingness-to-pay studies of wage differentials needed to compensate individuals for accepting a risk of death are a prominent example of a revealed preference technique. [130] Revealed preference approaches are poorly suited for determining the valuation of involuntary harms because they are based on the existence of market transactions, and such transactions are generally seen as voluntary. [131]

Thus, in order to estimate how the valuations of involuntary and voluntary risks differ, one needs to resort to a different approach. In recent years, a great deal of attention has been devoted to the implicit valuations of human life derived from dividing the total cost of an environmental program by the number of lives saved. The result, for environmental pro grams that do not have significant other benefits, is the implicit value that the regulatory program has assigned to each life. The range of implicit valuations for regulatory programs is enormous, from around $100,000 per life to a number in the billions of dollars. [132] To reach any worthwhile conclusions from these implicit valuations, one would need to make the heroic assumption that social expenditures in fact are reflective of public preferences.

Thus, a more promising alternative is to directly question individuals about the relative value that they attach to avoiding voluntary and involuntary harms. [133] In the most comprehensive study of this type, Maureen Cropper and Uma Subramanian conducted a nationwide telephone survey of 1,000 households, asking interviewees to compare an environmental program and a public health program designed to address a particular risk, such as respiratory illness or cancer. [134] The interviewees were first told that the two programs would cost the same amount of money and save the same number of lives, and were asked to determine which pro gram was best for society. [135] Then, they were told that the program that they had found less attractive would in fact save x times more lives than its counterpart. The authors computed the number of lives saved by each program that made the median respondent indifferent between the two programs.

The interviewees were also told to describe some qualitative characteristics for the risk addressed by each of the programs, and, for each characteristic, to place the risk on a ten-point scale. One of these characteristics was the ease with which the risk could be avoided, [136] which is a measure of the risk's voluntariness. [137] In each case, the public health risk was deemed to be more voluntary than the environmental risk. [138]

For the purposes of this Article, the most relevant pair examined by the researchers was radon control in homes and a pesticide ban on fruit. Radon control, like workplace hazards, is a paradigmatic voluntary risk: an individual can avoid the risk by making a monetary sacrifice. In con trast, pesticide control, like other environmental risks, generally cannot be addressed effectively absent some level of social coordination. For this reason, the risk should be regarded as involuntary. [139]

The respondents were asked to assess, on a ten point scale, the ease with which the respective risks could be avoided. The mean ratio of the ease with which the radon risk could be avoided to the ease with which the pesticide risk could be avoided was 1.31. [140] When respondents were told that the two programs would save the same number of lives (and cost the same), 72 percent chose the pesticide ban and only 28 percent opted for the radon control. [141] The median respondent was indifferent between saving 100 lives by means of the pesticide ban and 213 lives through radon control. [142] Thus, the median respondent implicitly found the life saved imperiled by the involuntary risk to be twice as "valuable."

More generally, the authors found, across the six pairs of risks that they studied, a consistent, statistically significant preference for addressing the less voluntary risk. [143] Moreover, a significant minority of respondents—between 20 and 30 percent—always preferred addressing the involuntary risk, regardless of how many more lives would be saved by transferring the resources to addressing the voluntary risk. [144]

b. Unrepresentativeness of the Population Exposed to Workplace Risks.—Another type of adjustment needs to be made when using valuations of life in workplace settings as a second-best measure of the appropriate value of life for environmental programs. Individuals who take relatively risky jobs have a comparatively low willingness-to-pay to avoid the risk. [145] Indeed, individuals with higher valuations would demand greater wage differentials to take a riskier job over an otherwise comparable job that was less risky. The employers, however, would not need to pay this higher premium if they could fill their jobs with workers who had lower valuations.

This concept can be illustrated by reference to an auction. The employer with the risky jobs offers a low wage premium and sees how many workers are willing to take the positions. If it does not fill all the vacancies, it offers a somewhat higher premium, and continues this process until it is able to fill all the jobs. Any workers who place a higher value on avoiding the risk end up not getting the job.

As a result, the willingness-to-pay valuations derived from the study of risky jobs are not the valuations of the mean or median member of society. Instead, they are the valuations of a relatively small subgroup with a disproportionate tolerance for risk.

In contrast, environmental risks in general affect a far broader sector of society. Moreover, because they are involuntary, there is no easy mechanism for individuals to self-select for such risks based on their lower-than-average valuations of risk. [146] Thus, an appropriate correction needs to be made when extrapolating from the workplace to the environmental arena. No empirical literature, however, sheds light on the magnitude of this correction.

3. Dread Nature of the Harm.—There is also an important difference in the nature of deaths resulting from industrial accidents on the one hand and from environmental exposures to carcinogens on the other. The former occur instantaneously and without warning. The latter often occur following a long and agonizing ordeal. As Cass Sunstein pithily notes: "All deaths are bad. But some deaths seem worse than others." [147]

A far greater level of social expenditures is devoted to combating toxic risks like cancer than risks of instantaneous deaths. A recent, admirably comprehensive study by Tammy Tengs and a number of co-authors compares the cost-effectiveness of various risk reduction regulations. [148] The authors first determine the cost per life saved by dividing the direct costs of the regulation by the number of lives saved. Then, they divide this cost per life saved by "the average number of years of life saved when a premature death is averted" to obtain the cost per life-year saved. [149]

The comparison of costs per life-year saved reveals enormous disparities. The median medical and toxin control measures cost $19,000 and $2,800,000 per life-year, respectively; the overall median is $42,000 per life-year. [150] The authors also found a wide disparity in occupational in terventions depending on the nature of the death. The median occupational intervention designed to avert a fatal injury costs $68,000 per life-year, whereas the median occupational intervention involving the control of toxins costs $1,400,000—more than 20 times as much. [151]

But as in the case of the comparison between voluntary harms and involuntary harms, one cannot draw strong conclusions from these disparities because public expenditures may well not reflect people's preferences. [152] Instead, a more direct measure of the difference in valuations is preferable.

A study by George Tolley, Donald Kenkel, and Robert Fabian at tempts to quantify the values attached to the avoidance of unforeseen, instantaneous deaths on the one hand and carcinogenic deaths on the other. [153] For each of these risks, the authors define a low estimate, a medium estimate, and a high estimate, and present their figures in 1991 dollars. For unforeseen, instantaneous deaths, the respective estimates, derived from a survey of willingness-to-pay studies, are $1 million, $2 mil lion, and $5 million, respectively. [154]

Because, as indicated earlier, there are no willingness-to-pay studies estimating the value of life lost from a disease with a long latency period, [155] the procedure used by the authors for estimating the value of carcinogenic deaths is more complicated. As their starting point, the authors use the estimates for instantaneous deaths. Then, for their low estimate, they add a component for the value of the morbidity period preceding the death. [156] This value is derived primarily from contingent valuation rather than revealed preference approaches. [157]

As the authors note, this estimate is conservative for two reasons. First, it understates the value of morbidity preceding mortality because conditions that eventually become fatal are more serious than nonfatal, chronic conditions. Second, it does not account for the dread aspects of carcinogenic deaths. [158] The authors account for these two components in their medium and high estimates, relying primarily on a survey of how individuals compare deaths from cancer to deaths from other causes, [159] and on contingent valuations of periods of severe limitations of activity preceding death. The authors' low, medium, and high estimates of the value attached to a life threatened by cancer are $1.5 million, $4 million, and $9.5 million, respectively. Thus, the medium valuation of life in the case of carcinogenic exposure is twice as high as the corresponding valuation for an unforeseen, instantaneous death. [160]

F. Choice of a Discount Rate

Parts of the preceding discussion have already hinted as to why the choice of the discount rate used in connection with the valuation of lives is more complicated

than merely picking the discount rate used for monetary flows. [161] I can invest $100 today at a 3.5 percent interest rate and have about $200 in 20 years. I cannot invest the utility that I derive from living a year at present and obtain, 20 years later, the utility that I would then derive from living 2 years. [162] Similarly, I can sell the right to get a payment of $200 in 20 years for a present payment of about $100. I cannot engage in a comparable transaction with respect to the utility that I would derive from living in 20 years. As W. Kip Viscusi notes, "One cannot trade health . . . across time . . . . If we value our health at 45 but do not at 25, then we cannot simply shift health status across time in the same way that we would shift monetary resources." [163]

This section undertakes two separate tasks. First, it reviews empirical evidence suggesting that, despite the conceptual difference between the two, there is no statistically significant difference between the discount rate that individuals apply to future health risks and the discount rate that financial markets apply to flows of money. Second, it criticizes OMB's approach with respect to discounting, especially as applied to future health risks, showing that OMB employs a rate that is inappropriately high.

1. Discounting Health Risks v. Discounting Financial Flows.—Thoughtful analysts have recognized that the discount rates applied to financial flows cannot be applied mechanically to the discounting of the utility that comes from living in the future. [164] The most extensive empirical work in this area is that of Michael Moore and W. Kip Viscusi, who seek to deter mine whether the rates of discount for health risks differ from the financial rates of time preference. [165]

In their most recent article on the subject, Moore and Viscusi estimate the implicit discount rate exhibited by workers facing a probability of instantaneous death as a result of job risks. [166] They employ a temporal model that assumes that all life years are valued equally, [167] and attempt to determine the relationship between wage premiums and job risks as a function of the remaining years of workers' lives (and other relevant characteristics). [168]

For example, consider two workers who have the same life expectancy and are otherwise also identical, but who demand different wage premiums for undertaking a risky occupation. The worker with the higher valuation (who therefore demands the higher wage premium) has a lower discount rate and therefore values more highly than her counter part the years that she will lose in the future. Alternatively, if two workers who have different life expectancies but are otherwise identical were to demand equal wage premiums, the worker with the shorter life expectancy will be exhibiting a lower discount rate: she will be valuing the future years more highly than the other individual.

On the basis of an empirical study of 1463 workers, Moore and Viscusi calculate a real discount rate of 2 percent. [169] The authors note that this real rate "accords roughly with financial market interest rates for the period, once these nominal rates are adjusted for inflation." [170] Their results, therefore, "provide no empirical support for utilizing a separate rate of discount for the health benefits of environmental policies." [171]

Moore and Viscusi reach this conclusion despite their earlier studies, which had found discount rates in the 10–12 percent range. [172] They maintain that the confidence limits around these estimates were sufficiently large that the results should be thought of as "quite similar." [173] The authors conclude:

In each case the confidence intervals for the discount rate estimates overlap available market rates of return. Moreover, since the point estimate of the discount rate falls short of the market rate in one case and exceeds the market rate in two cases, we find no clear evidence of systematic differences between discount rates for health and financial rates of time preference. [174]

With respect to the control of environmental carcinogens, it is relevant that the authors found that education has a large effect on the discount rate. In a study that found an overall real discount rate of 11 percent, the rates for workers with 8 years of schooling and college-educated workers were 15 percent and 5.5 percent, respectively. [175] Thus, to the extent that workers in risky occupations have a lower-than-average level of educational attainment, a downward adjustment on the discount rate would need to be made. For environmental carcinogens, this factor strengthens the authors' conclusion that the discount rate exhibited by financial markets is appropriate. [176]

To conclude, it is worth noting that the methodology used to estimate the rate at which individuals discount future utilities may lead to an overstatement of this rate. Recall that Moore and Viscusi assume that all life years are valued equally. [177] This assumption is consistent with the standard approach in life-cycle models, in which the utilities derived from living in particular years are a function solely of the level of consumption available in those years. [178] It is plausible, however, that

such utilities are affected also by one's age, and that they fall (for a given level of consumption) with increasing age, as a result of the deterioration of one's physical capacity.

For example, at age 50, one might not be able to engage in the full range of pleasurable activities that one could have undertaken at age 30. Thus, the choices on how to convert consumption resources into utility at age 50 would be more constrained. [179] If this were the case, part of the lower valuation attributed to later years in one's life would result from the lower utility derived from living during those years, rather than from discounting to reflect the passage of time. As a result, the discount rate estimated from a model in which utilities are constant across time (or a function only of the magnitude of resources available for consumption) would overestimate the actual discount rate.

2. Selecting an Appropriate Rate.—The choice of a discount rate is a key variable in the cost-benefit analysis of many environmental regulations. Because the costs of regulatory programs are typically borne around the time that the regulations go into effect but the benefits, in the case of latent harms, do not accrue for decades into the future, the higher the discount rate, the less desirable the regulation will seem. Re call, for example, that in the Corrosion Proof Fittings case, the present discounted value of the benefits would have been approximately ten times greater under a 4 percent discount rate than under a 10 percent discount rate. [180]

The OMB policy on discount rates does not address specifically the issue of how to discount health risks. [181] Thus, these risks are discounted at the rates used in the evaluation of government projects in general, and government regulation in particular.

Until 1992, OMB employed a discount rate of 10 percent pursuant to a policy contained in its Circular A–4.[182] In 1992, OMB amended this circular to mandate a real discount rate of 7 percent. [183] OMB justifies this rate as "the marginal pretax rate of return on an average investment in the private sector in recent years." [184]

The OMB policy, however, uses a different discount rate for cost-effectiveness analysis—that is, to determine which of several programs yielding identical benefits has the lowest cost in present discounted terms. For this purpose, OMB employs the real return on long-term government debt—the interest rate on long-term government bonds minus the rate of inflation. [185] In recent years, this figure has fluctuated between 3 percent and 4 percent. [186]

The use of different rates for cost-benefit and cost-effectiveness analysis can produce perverse results. For example, consider two policies that have the same benefits, which are designed to address a future risk. Policy A costs $700,000 at present whereas Policy B costs $1,200,000 in 10 years (the figures are in constant dollars). At a 3 percent discount rate, the present discounted value of the cost of Policy B is higher than $700,000, and thus Policy A would be preferred on cost-effectiveness grounds. On the other hand, at the discount rate of 7 percent, which would apply to cost-benefit analysis, Policy B would be more attractive.

Cost-effectiveness analysis can be used as a short-cut to cost-benefit analysis where the benefits of two policies are the same. But logic compels that the policy with the most attractive cost-benefit ratio also be the most cost-effective. This consistency requirement can be violated when the discount rates used for cost-benefit and cost-effectiveness analysis are different. Otherwise a trivial difference, say of one dollar, in the benefits of the two policies (so that cost-benefit analysis rather than cost-effectiveness analysis must be used) would alter the choice between two policies that are essentially identical.

More fundamentally, however, there appears to be a growing consensus in the economics literature that the appropriate real discount rate for government projects is the real return on long-term government debt—the interest rate on long-term government bonds minus the rate of inflation. The underlying issues are quite complex, but can be simplified considerably for the purposes of this discussion. [187]

When the government undertakes a regulatory project, it is trading costs and benefits on behalf of its citizens. As Frank Arnold notes, "it then seems reasonable to discount the future benefits to the present using the same rate that the affected citizens would use, for it is on their behalf that the project is undertaken." [188] This rate, often referred to in the literature as the "consumption" rate of interest, [189] is generally taken to be the after-tax rate of return, adjusted for inflation, [190] on relatively risk-free financial instruments, [191] such as government bonds. In recent years, the economics literature has generally called for the use of a real discount rate of 2–3 percent. [192]

There is a complication, however. Consider initially two environ mental projects undertaken directly by the government, one financed by taxes and the other by borrowing. In the case of the project financed by taxes, the taxes will reduce the consumption of goods, so discounting the benefits at the consumption rate of interest

is the appropriate procedure: individuals are simply trading off less consumption now, as a result of the taxes, for future benefits flowing from the project. [193]

The situation is potentially different if the government finances the project through borrowing. In a closed economy, with no capital flows into the country, the borrowing would displace money available for private investment. Because the returns from this investment yield taxes, its displacement would produce a loss to the government, equal to the fore gone taxes. [194]

An analytically analogous situation is posed by environmental regulation that imposes costs on firms, if these costs cannot be shifted to con sumers. In a closed economy, such investments would displace other private sector projects. [195]

The appropriate discount rate under these circumstances is the marginal pre-tax rate of return on private investment—the rate used by OMB. [196] After this return is taxed by the government, the remaining return must be sufficient to cover the consumption rate of interest. If the return on the government's project was lower, social welfare would be enhanced by not undertaking the government project and thereby not displacing the private investment. [197]

In summary, traditionally, the literature on cost-benefit analysis inquired as to whether the project under consideration displaced consumption or private investment. It used the consumption rate of interest in the former case and the rate of return on capital in the latter. [198]

In recent years, however, the assumptions underlying this bifurcated approach have been called into question. In particular, increasing globalization has led to the integration of capital markets and the opening of the U.S. economy to foreign investment. [199] As a result, our economy can no longer realistically be viewed as closed. In an open economy, the level of taxable investments is unaffected by environmental regulation because no capital projects are displaced; the government therefore does not lose the corresponding tax revenues. Under these conditions, the consumption rate of interest is the appropriate discount rate. [200]

Consistent with this view, the consumption rate of interest is currently used as the discount rate by the General Accounting Office (GAO) and the Congressional Budget Office (CBO). [201] Even EPA, which must submit its proposed and final regulations to OMB for review under Executive Order 12,866, has used a 3 percent discount rate in connection with a proposed regulation designed to address lead-based paint hazards. [202] Other agencies, however, have explicitly linked their discount rate to OMB's. [203]

G. Estimating the Undervaluation of Lives Under OMB's Policy

Section E explains the nature of the corrections that need to be made to intelligently translate the existing valuations of life from industrial accidents to appropriate valuations for environmental harms in general and carcinogenic harms in particular. Section F discusses how to choose an appropriate rate to discount the utility of life-years saved at the end of a latency period. The purpose of this section is to obtain a rough estimate of the underestimation of the value of human life that results from the OMB approach of taking valuations from workplace settings and mechanically reducing them by an inappropriately high discount rate over the length of the latency period. Because of OMB's role as the arbiter of regulatory analysis under Executive Order 12,866, this undervaluation has important public policy consequences.

Once again, the focus is on comparing the valuation of two different 40-year olds: one who faces a probability of instantaneous death in an industrial accident, V[in'40,40'], and the other who faces a probability of death at age 60 from an environmental carcinogen with a 20-year latency period, V[in'40,60']. Recall the two factors that make V[in'40,60'] smaller. [204] First, assuming for the sake of simplicity that these individuals would otherwise die at age 80, the number of life-years lost from the carcinogenic risk is only half. Second, the years lost from the carcinogenic harm occur later, and discounting is therefore appropriate; at a discount rate of 3 percent, the discount factor is 0.55. So, using round numbers, if these two corrections were the only relevant ones, V[in'40,60'] would be about one-quarter of V[in'40,40'], reflecting reductions of about one-half each on the account of the discounting and the difference in the life-years saved, respectively.

One should not overlook, however, the corrections on the other side, particularly those resulting from the involuntary nature of the environmental harm compared to the voluntary nature of the workplace harm, and the dread nature of deaths from environmental carcinogens compared to the non-dread nature of deaths from instantaneous industrial accidents. With respect to the first adjustment, the Cropper and Subramanian study, which compares deaths from voluntary and involuntary harms, suggests that an adjustment by a factor of two is appropri ate. [205] As to the second

adjustment, the study by Tolley, Kenkel, and Fabian finds that avoiding deaths from cancer is valued twice as much as avoiding instantaneous deaths. [206]

There is a question about how to combine the results of these two studies. It is not completely clear that the correction from the Tolley, Kenkel, and Fabian study is based only on the dread nature of the harm, and is not also affected by different degrees of voluntariness of the harm. If the carcinogenic and non-carcinogenic harms compared by these authors shared the same level of voluntariness, then it would be reasonable to multiply the two factors of two, and conclude that an adjustment by a factor of four is necessary to account for the differences in voluntariness and dread.

In contrast, if the carcinogenic harm considered in their estimate is less voluntary than the non-carcinogenic harm, such a correction would be excessive. It is clear that the difference in valuations comes in part from the morbidity that precedes carcinogenic deaths—one component of the dread nature of cancer. [207] Moreover, nothing in the survey on which this study relied for the remainder of the correction focused the attention of the respondents on differences in the level of voluntariness. [208] Thus, it seems unlikely that this issue would have played a large role in the valuations. [209]

While further research on these matters is clearly needed, to a first approximation it is reasonable in light of the designs of the two studies to treat the two factors as multiplicative. Thus, other things being equal, the value of avoiding a death from an involuntary, carcinogenic risk should be estimated as four times as large as the value of avoiding an instantaneous workplace fatality. This upward adjustment thus cancels the two downward adjustments resulting from the fewer number of life-years lost and the discounting for the latency period.

Moreover, other upward adjustments are necessary as well. [210] First, as indicated above, the median salary for all wage earners is about 23 percent higher than the median salary for operators, fabricators and laborers, the U.S. Census category most likely to contain the subjects of willingness-to-pay studies in the context of industrial accidents. [211] Thus, the valuation of lives threatened by environmental carcinogens should be the subject of an upward adjustment of another 23 percent.

Second, economic growth must be accounted for. As a result, based on the 1982–1996 period, the discount rate used in making the down ward adjustment necessary to account for the fact that the life-years would be lost in the future should be reduced by about 1 percent. [212] Thus, accounting for economic growth leads to an upward adjustment of the valuation of life of 22 percent. [213]

As indicated above, the OMB approach is to take the valuations of life from workplace settings and discount them for the length of the latency period at a rate of 7 percent. [214] While this approach does not reduce the valuation to reflect the smaller number of life-years saved, [215] using a 7 percent discount rate instead of a 3 percent rate over a 20-year latency period leads to a downward adjustment of the valuation by a factor of about four, rather than by a factor of about two. [216] One would arrive at the same downward adjustment by a factor of four, however, if one took account of the smaller number of life-years saved and discounted at a 3 percent rate.

Moreover, the OMB approach neglects to perform any of the necessary upward adjustments. Thus, over a 20-year latency period the approach may undervalue human life by a factor of about six. [217] For contaminants with longer latency periods, the undervaluation would be even greater. [218]

Finally, this estimate of the undervaluation that results from the OMB approach is probably a lower bound. The true figure may well be higher because the calculation is based only on those differences between instantaneous deaths from workplace accidents and deaths from environ mental carcinogens that can be quantified on the basis of plausible empirical studies. The preceding discussion has identified two additional possible sources of undervaluation, but the quantification of the impact of these sources is not possible as a result of the lack of relevant empirical analysis. First, and probably most importantly, the population exposed to workplace accidents has a comparatively low willingness-to-pay to avoid death, as a result of a disproportionate tolerance for risk. [219] Second, to the extent that, for a given level of resources available for consumption, the utility of being alive at a particular age falls with increasing age, the estimates in the literature of the rate at which individuals discount their future consumption would be higher than warranted. [220]

H. Recasting the Debate

It is now worth highlighting that this Article's approach to discounting in an intragenerational setting does not pose significant ethical issues that are distinct from those raised by cost-benefit analysis in general or the valuation of human life in particular. [221] In principle, one could directly ascertain, through willingness-to-

pay studies, the value of lives threatened by latent harms. Because practical problems stand in the way of obtaining such valuations, a second-best measure, constructed in part by means of discounting future utilities, must be used instead. [222] The use of such a proxy, however, does not give rise to ethical issues other than those that might exist if the measurement were done directly.

The reason for discounting in the case of latent harms is not that a regulator or some other outsider determines that life in the future is less valuable than life in the present. [223] Instead, discounting simply reflects the fact that the individual who is valuing her own life derives less utility from living a year in the future than in the present. [224] Discounting is therefore necessary to provide an accurate value of the utility that the individual loses in the present as a result of a premature death that might occur in the future.

At the same time, however, discounting is only one of many necessary adjustments that need to be made when valuations in the context of industrial accidents are used as the starting point to construct a value of human life for the purpose of regulating environmental carcinogens. It has no greater call for legitimacy than any of the other adjustments analyzed in Part I.E. As the various empirical estimates show, it is not even dominant in terms of magnitude. [225] Thus, the failure of the regulatory process to make other adjustments, principally as a result of OMB's approach to the matter, leads to a substantial undervaluation of human life. [226]

The preceding discussion views discounting in this intrapersonal situation raised by the presence of latent harms as an essentially technocratic procedure, which must be undertaken in conjunction with other adjustments of the value of life from instantaneous industrial accidents, in order to obtain a second-best estimate of the value of a human life threatened by latent environmental contaminants. This characterization of the problem may give rise to two types of concerns. Neither, however, calls for a reevaluation of the ethical status of discounting in the case of latent harms.

First, one might worry that an individual's decisions today do not sufficiently protect the person that the individual might become in several decades. This perspective views the individual as a succession of "multiple selves." [227] Its concern is that the individual's current self would make decisions that undervalued the interests of the individual's future self by choosing a discount rate that was too high. This formulation gives rise to a typical externality problem and converts a technocratic intrapersonal problem into an ethically laden quasi-interpersonal one.

The objection, however, would not be confined to the role that discounting plays as a step toward a second-best valuation of human life threatened by latent harms. Precisely the same objection could be lodged against an attempt to measure this value directly through willingness-to-pay studies. One would worry in this context that the wage premiums demanded by an individual would be too low because the future costs would be borne not by her current self but by a future self. The complaint would thus not be attributable to the specific role played by discounting but, more generally, to the process of valuing life itself. Thus, as a formal matter, the objection does not disprove my claim that discounting in an intragenerational setting poses no significant ethical issues that are distinct from those raised by cost-benefit analysis in general or the valuation of human life in particular. [228]

Moreover, such a criticism of revealed preference approaches to the valuation of threats to human life would not be confined to latent harms. Take, for example, an instantaneous industrial accident in which an individual faces probabilities of both death and serious morbidity. The individual's current self might not have sufficient empathy toward a future self confined to a wheelchair, and might therefore demand too low a wage premium.

More broadly, most decisions that we make have future consequences. Every time that we borrow money, we reduce the resources that will be available to us in the future. Similarly, every current expenditure affects the amount that will be available for future expenditures. To find an externality in each decision with future consequences as a result of the presence of multiple selves would open the door to government regulation of essentially every financial decision that we make. Such an approach would therefore constitute a serious affront to individual autonomy.

Interfering with individual preferences in this manner might be appropriate in the face of fairly egregious myopia. For example, in the somewhat analogous context of social welfare policy, Bruce Ackerman and Anne Alstott note:

The aim of liberal policy is not to second-guess [individuals'] choices by supposing that everybody 'ought' to save a lot for retirement if they are to maximize their happiness over their life times. Its mission is more modest but more fundamental. It is to protect elderly citizens against the worst consequences of their earlier psycho-

logical myopia. The watchword is not utility maximization but the assurance of dignified existence in old age. [229]

It would be unwarranted, however, to attack this Article's approach to the problem of latent harms by deploying the machinery of "multiple selves" analysis. Recall that the approach advocated here is to use the after-tax return on riskless investments—a rate that currently stands at between 2 and 3 percent. [230] If this rate were to be trumped as insufficiently protective of the future, one would need to trump every decision to borrow money at market rates of interest. Then, governmental regulation of individual choices in the face of any decision with future consequences would become the norm, rather than a relatively rare club to be wielded only in the face of egregious lack of foresight.

A different type of objection might be raised to the claim that, in the context of latent harms, discounting is a technocratic exercise that does not give rise to difficult ethical choices. Different individuals have different discount rates, but the social decision of how to control latent environmental harms needs to be based on a single rate. Thus, in choosing the rate on which to base social policy, one needs to make some type of interpersonal comparison. Such comparisons, which are highly value laden, are inevitable, even if they are made implicitly by using a common rule of thumb such as basing the policy on the median discount rate.

Because environmental quality is a public good, once the government acts, individuals will enjoy a uniform level of quality regardless of their individual discount rates. Thus, individuals with low discount rates would be exposed to more latent harms than they would have preferred, and individuals with high discount rates will be exposed to harms that are lower than they would have preferred (and consequently, perhaps, would have to face too high a current financial sacrifice to fund the policy).

This objection, again, is not particular to the role played by discounting future utilities in the case of latent harms, but can be raised more generally against both cost-benefit analysis and the valuation of human lives. Under cost-benefit analysis, public policy is chosen on the basis of the aggregate valuations of the benefits. Thus, individuals with particularly high valuations have to accept a policy that is laxer than they would have preferred, whereas individuals with a particularly low valuation face the opposite problem. Similarly, in the case of public policy decisions taken to prevent even instantaneous deaths, individuals who value their lives particularly highly (perhaps because they are unusually wealthy or have a particularly low tolerance for risk) will face a policy that is laxer than they would have preferred.

In summary, to the extent that the valuation procedures discussed in Part I give rise to ethical objections, these objections should be leveled either against cost-benefit analysis generally or against the valuation of life in particular. [231] If these two techniques survive ethical scrutiny, no substantial independent ethical argument should be raised against the role played by discounting in an intragenerational setting. More generally, it is not defensible to argue that the value assigned by the regulatory process to a human life should be independent of when an individual's life-years are lost, regardless of how the timing affects the individual's own valuation.

II. HARMS TO FUTURE GENERATIONS

As indicated at the outset of this Article, discounting at a rate of re turn comparable to that earned by financial investments turns the utilities of generations living a few hundred years from now into a negligible present discounted value. [232] Under such conditions, practically no current expenditure for the benefit of relatively distant generations could be justified within a cost-benefit framework. Because many of the consequences of climate change will not manifest themselves for a long time, [233] the consequences of discounting at the rate of return of financial instruments may well be to make any plausible expenditure to address climate change fail a cost-benefit test.

The emphasis of many economists on the use of constant discounting models stands in stark contrast to the approach of international environmental law, which has given its unqualified endorsement to an alter native concept to guide intergenerational allocations: the principle of sustainable development. Indeed, the concept of sustainable development figures prominently in the most important agreements concerning international environmental law, [234] including the Stockholm Declaration, [235] the Rio Declaration, [236] and the Framework Convention on Climate Change. [237]

Section A shows that models of discounting harms to future generations cannot be justified merely through appeals to logic. Section B reviews the empirical lit-

erature concerning how individuals would discount benefits to future generations. The results reveal a strong intuition against the use of constant discounting models. Section C analyzes the serious shortcomings of discounting models when they are used in an intergenerational context. Section D discusses the role of opportunity costs; even if future utilities are not discounted, expenditures for environ mental projects might nonetheless be postponed if other investments can yield higher returns. Section E analyzes the principle of sustainable development and shows why it too suffers from serious shortcomings. Finally, Section F presents the outlines of an attractive theory of intergenerational obligations with respect to the environment.

A. Discounting and Appeals to Logic

Some proponents of discounting the benefits to future generations justify their position through appeals to logic, invoking a set of absurd consequences that would inexorably follow if discounting was not per formed. Their arguments in this regard are unpersuasive.

1. No Environmental Projects Will Be Undertaken Unless One Discounts at a Market Rate.—Some commentators argue that unless environmental benefits are discounted at the rate of return on other investments, environmental expenditures would always be deferred into the future and ultimately would never be undertaken. For example, Susan Putnam and John Graham state:

If a smaller discount rate were to be applied to health than to money, it would always make sense to postpone adoption of public health programs that invest money now for deferred health improvements. In short, society would continually delay risk reduction into the future and impose the burdens on future generations. [238]

Similarly, according to Emmett Keeler and Shan Cretin:

The discounting of costs but not benefits . . . has a paralyzing effect on a decisionmaker. . . . For any attractive program, there is always a superior delayed program which should be funded first. The result is that no program with a finite starting date can be selected. [239]

The idea behind this position is that, instead of undertaking the environ mental program, one could invest the funds in an alternative project, watch the investment grow, and then address the environmental problem at some time in the future. At this future time, moreover, one would engage in the same calculus and decide to postpone the environmental expenditure once more.

Environmentalists have traditionally favored low discount rates be cause the costs of environmental protection generally must be borne well before the benefits begin to accrue. [240] Thus, a low discount rate makes a given expenditure seem more desirable. The argument that no environ mental programs would be undertaken absent discounting at a market rate turns this view on its head: lack of discounting becomes environ mentally undesirable.

There are several responses to the justification of the discounting of environmental benefits by an appeal to a seemingly logical claim that any alternative would lead to the indefinite postponement of environmental expenditures. To begin, regardless of whether one discounted the environmental benefits at the market rate, it would always be desirable to undertake environmental investments that yielded a market rate of re turn. So, the claim has to be somewhat more modest: that only environ mental investments yielding at least a market rate of return would be undertaken. Other environmental projects, in contrast, would be delayed forever because they would always look more attractive in the future, after the funds that would have been allocated to these projects earned a higher rate of return elsewhere. [241]

There is then a seemingly inescapable logic to discounting environ mental benefits at the rate of return earned by other investments. If one used a lower discount rate for environmental benefits, environmental remediation projects could pass a cost-benefit inquiry even though the resources would be best spent elsewhere. The use of a discount rate equal to the rate of return on other projects ensures that only desirable projects pass a cost-benefit test. [242]

Even with this reformulation, however, the appeal to logic assumes implicitly that the costs and benefits of the environmental program will remain unchanged over time; [243] it is because of this invariance that delaying expenditures in order to invest at the market rate of return seems attractive. This assumption, however, is inconsistent with the structure of many environmental problems.

For example, in the case of the remediation of hazardous waste sites under the Superfund program, the damages caused by the contamination are likely to increase significantly over time if the problem is left unattended. [244] If addressed early, a cleanup can take place before the hazardous waste has seeped down to an aquifer,

affecting the quality of the groundwater. At this stage, the cost of remediation is comparatively modest and the damage from the contamination (and therefore the benefit of undertaking a remediation) is comparatively modest as well.

A few years or decades later, however, the pollutants may have worked their way down to the aquifer. [245] Then, the damage may be far higher, since the pollutants could have destroyed important sources of drinking water. In turn, the costs of remediation would be far higher as well. [246]

Alternatively, certain environmental problems may become irreversible. Once that occurs, any finite expenditure on abatement, no matter how high, will fail to remedy the problem. The costs of abatement will effectively have increased to infinity.

Thus, in deciding whether to undertake an environmental project now, one cannot merely perform a static calculation of the magnitude of costs and damages on a particular date. One needs also to look at the problem dynamically and determine how the costs and damages would vary over time if the problem were left unattended.

Consider the following simple example. We could remove some soil from the site and incinerate it now at a cost of $110, [247] and the damage from the current contamination is $100, reflecting a small increase in the cancer risk of certain residents in neighboring areas. If one looked at these figures statically, one would decide, on cost-benefit grounds, not to undertake the cleanup. If the problem is left unattended, however, in 10 years the remediation cost would be $500, as a result of the need to pump and treat groundwater, and damage from the contamination would be $600. At that point, the cleanup would be justifiable on cost-benefit grounds. For any plausible discount rate, however, it would be better to spend the $110 upfront to remove and incinerate the contaminated soil, thereby addressing the current $100 damage problem as well as preventing it from becoming a $600 damage problem in the future.

Thus, the situation described above presents three policy options: remediate now, remediate later, or do not remediate. It is desirable to remediate now not only when the current damage is greater than the current cost of addressing this damage, but also when the future damage is greater than the future cost of addressing it, and the increase in costs in the intervening period is greater than the rate of return on other investments. [248]

These features concerning the structure of environmental benefits and costs are no less an issue for climate change than they are for Superfund problems. [249] Certain climate change problems may be irreversible, [250] and in such cases delaying investment in the environmental project is not an option. More generally, to make intelligent policy choices one needs to know, for example, not only the costs and damages at the time that carbon dioxide loadings in the atmosphere are doubled relative to some baseline, but also how the damage changes over time and the extent to which this damage can be reduced by means of particular policy measures. [251]

In addition, in the case of climate change, there is the possibility of catastrophic consequences. [252] In the face of such consequences, risk aversion would justify undertaking projects even if their expected return was lower than that of other projects. [253]

Moreover, the view that before addressing environmental programs we should exhaust higher-yielding investments in other areas overlooks important difficulties concerning the transfer of resources across projects. [254] Say, for example, that initially the greatest returns to a given investment would be to improve the educational system of particularly poor developing countries. [255] Over the first 20 years, resources in vested in this manner earn a greater return than if they had been placed in an environmental project. Moreover, over this period, the costs of environmental remediation are increasing at a rate lower than the return on the educational investment.

After 20 years, however, the calculus changes. The costs of the environmental project, though less than the resulting benefits, begin to rise at a rate higher than the rate of return to education in the developing country. At that point, it is desirable to take the proceeds of the educational investment and transfer them to the environmental investment.

There is good reason to be skeptical about the feasibility of this transfer. Part of the returns from the educational investment may have been consumed by its beneficiaries, and may therefore no longer be available to fund the environmental project. Other resources may be sunk in long-term investments, such as infrastructure, from which they could not feasibly be extricated.

The transfer of even liquid investments may raise problems. The developing countries (or whatever interest group benefits from the initial allocation) might object to having the resources transferred to address a problem that they attribute to developed countries. Absent their con sent, there might be no clear mechanism for

effecting the transfer. Of course, one could attempt to deal with this problem ex ante by contracting between the provider of the funds and the temporary recipient. Nonetheless, there are likely to be difficulties enforcing the rights under such a contract.

In summary, the resort to logic must fail. Perhaps the argument could be further recast to state that environmental expenditures should not be undertaken if other projects have a higher return, if the costs and damages associated with leaving the environmental problem unattended do not rise too fast, if the potential for catastrophic environmental consequences in the absence of immediate measures is sufficiently low, and if the difficulties of transferring resources across projects are not insurmountable. Then, of course, the claim made by supporters of discounting would have lost all their bite and would have become essentially tautological.

2. Failure to Discount Would Lead to the Impoverishment of the Current Generation.—A different argument maintains that not discounting the value of benefits to future generations makes it desirable for us to impoverish ourselves down to subsistence levels for the benefit of future generations. As Tyler Cowen and Derek Parfit describe the argument (to which they do not subscribe):

We clearly need a discount rate for theoretical reasons. Other wise any small increase in benefits that extends far into the future might demand any amount of sacrifice in the present, be cause in time the benefits would outweigh the cost. [256]

The logic is not limited to our generation. In turn, subsequent generations face the same incentive, and they become impoverished as well. Thus, "failure to discount would leave all generations at a subsistence level of existence, because benefits would be postponed perpetually for the future." [257]

There are two serious problems with the argument. First, it assumes implicitly that the objective of the decisionmaker is to maximize a social welfare function that adds up the interests of all generations. Then, deferring consumption now makes additional resources available for the future, when more people are around to derive utility from them. The question of whether it is appropriate to determine our obligations to future generations by reference to an aggregate social welfare function can not be resolved as a matter of logic. Instead, it must be defended by means of an ethical theory. [258] The argument that all generations will be impoverished unless we discount environmental benefits assumes away the hard ethical choice, [259] and then notes that an absurd conclusion would follow absent discounting.

Moreover, the argument for discounting as a way to avoid impoverishment takes a truncated and fundamentally misleading view of the manner in which one generation affects the welfare of subsequent generations. One component, to be sure, is through its consumption of renewable and nonrenewable resources. Thus, one way in which we could attempt to impoverish ourselves is by foregoing the consumption of such resources.

But to a large extent the standard of living of future generations will depend on current investments in areas such as technological knowledge, educational attainment, and productive capacity. [260] Would our generation make those investments if it was wholly deprived of the resulting benefit? The answer, presumably, must be negative—that the level of effort that we bring to the business of making investments with long-term consequences is a function of the benefits that we can realize from those investments.

As a result, a requirement that we impoverish ourselves to leave more resources for future generations could actually decrease, rather than in crease, the resources available in the future. One might respond by saying that our generation has an obligation to provide the level of investment that it would have provided under a regime in which it could at least share in the fruits of its labors. That may well be a plausible argument, but it derives from an ethical judgment. Thus, the appeal to logic fails here as well.

In summary, the failure to discount does not inexorably lead to the impoverishment of all generations; it does so only if one makes two ethical judgments: that the appropriate social welfare function adds up the utilities of all generations, and that the current generation has an ethical obligation to invest in a stock of activities affecting long-term well-being even if it cannot keep any of the resulting benefits.

B. Intuitions About Discounting

Before proceeding further, it is worth reviewing some empirical studies seeking to determine how individuals think about long-term discount ing issues. A caveat is appropriate at the outset. If individuals in the cur rent generation indicate that they would discount the benefits of future generations, one should not automatically conclude that the decision reflects an honest ethical judgment. Instead, the judgment of these individuals might be compromised by self-interest. On the other hand, it would be relevant if members of the current generation, despite their self-interst

to the contrary, were prepared to make social decisions protective of future generations. Their generosity might be indicative of an ethical in tuition that the benefits accruing to future generations should not be discounted very much, or perhaps not at all.

Most of the empirical studies in this area use a similar methodology. Typical of the approach is the questionnaire prepared by Maureen Cropper, Sema Aydede and Paul Portney, which states:

Without new programs, 100 people will die this year from pollution and 200 people will die 50 years from now. The government has to choose between programs that cost the same, but there is only enough money for one . . . . Which program would you choose? [261]

In their surveys, the authors varied the number of lives that would be saved in the future (but kept constant at 100 the number of lives saved in the present). They also varied, between 5 years and 100 years, the time at which the future lives would be saved. [262] From the responses, they computed the discount rates that the respondents assigned to future consequences. The mean of the respondents' discount rates was 8.6 percent, 6.8 percent, and 3.4 percent, for time horizons of 25, 50, and 100 years, respectively. [263] A similar study, conducted in Sweden, calculated discount rates of about 25 percent, 12 percent, and 8 percent, for time horizons of 20, 50, and 100 years, respectively. [264]

More strikingly, another Swedish study sought to compare the seriousness of a leakage of spent nuclear fuel at times ranging between one thousand and almost two million years into the future. Almost one third of the respondents did not discount the future consequences at all. Among those who did, the mean discount rate attached to an accident in the year 10,000 was less than one-hundredth of 1 percent—practically zero. [265]

The studies reveal an essentially unanimous opposition to the core component of the traditional discounting model: that future consequences should be discounted at a constant rate and that the rate of discounting should be set by reference to the rate of return on particular investments. [266] Instead, the studies show a consistent pattern under which the discount rate falls as the time horizon gets longer. [267] More over, the discount rate with respect to very long time horizons is well under the rate of return on investments in financial markets. [268]

C. Discounting in a Global Utilitarian Calculus

Thus, at this point the argument has established that the propriety of discounting the benefits to future generations cannot be resolved by appeals to logic. Moreover, empirical studies reveal a moral intuition opposed, over the long-term, to constant discounting at a rate of return comparable to that generated by financial markets. It is now time to focus directly on the propriety of discounting.

Most economic formulations of discounting in an intergenerational context posit a social welfare function that aggregates the utilities of individuals in the different generations. [269] For each time period, the utility is multiplied by a rate of pure time preference, which is a measure of the difference in importance attached to current utility as compared to utility in the future. [270] This rate could be zero (the utilities of current and future generations have the equal importance) or positive (the utilities of earlier generations are privileged). [271] The goal of the decisionmaker is to maximize the aggregate utility function. [272]

In this framework, the discount rate that maximizes aggregate utility can be written as follows:

d = [rho] + [THETA] g where d is the discount rate, [rho] is the rate of pure time preference, [THETA] is the absolute value of the elasticity of marginal utility (a measure of the relative effect of a change in income on utility), and g is the growth rate of per capita consumption. [273]

The pure rate of time preference, [rho] , reflects the fact that if the social welfare function gives less weight to the utilities of later generations, then those utilities must be discounted in order to make them comparable to the utility of the current generation. The term composed of the product of [THETA] and g has a less direct genesis. Most economic models of discounting assume that individuals in the future will enjoy higher rates of consumption than individuals in the present: more specifically, the level of consumption will increase at a rate of g. [274] The models also assume that individuals exhibit a declining marginal utility of consumption—that is, that a unit of consumption has a greater effect on the utility of an individual with a lower level of consumption than on one with a higher level of consumption. [275]

As a result, if later generations will enjoy a higher level of consumption as a result of economic growth, social welfare can be increased by allocating some additional resources to earlier generations. The [THETA] g term represents the amount

of discounting that must be performed, in order to maximize social welfare, on account of the higher levels of consumption of later generations.

The following subsections deal specifically with each of the two components of the discount rate.

1. Pure Rate of Time Preference.—Exemplifying the position of many economists, Victor Fuchs and Richard Zeckhauser take a strong position in favor of discounting at the rate of return on financial instruments. They maintain:

Most policy planning discussions assume full altruism—future citizens are given equal weight with present citizens—and discount solely for the time value of money. Given this ethical premise, the value of life years to future generations should be discounted at the time-value-of-money rate. [276]

Terming this approach "full altruism" is somewhat contrived. In fact, it privileges the interests of the current generation to a very large extent.

Recall that, at a time-value-of-money rate of 5 percent, this approach equates the loss of one life today with the loss of a billion lives in 500 years. [277] Stated somewhat differently, assume that the population of the world remains constant at about 6 billion people over the next 500 years. Under a model of time discounting, what would be the maximum current expenditure that could be justified in order to prevent the death of every living individual in 500 years? Placing a value of life of $5 million, in constant dollars, the maximum current amount that we could justify spending now to avert the destruction of the human race in 500 years would be $30 million. (At the OMB rate of 7 percent, this amount would be only about $10!) More conventional definitions of altruism would presumably call for a different result.

Indeed, the discount factors are simply the weights used to compare the value attached to the utilities of individuals in different generations. A pure rate of time preference of zero is equivalent to giving the utility of persons living at different points in time the same weight in the social welfare calculus. [278] Any positive rate simply reflects the preferences of a social welfare evaluator to depreciate the utilities of future generations. [279]

The ethically compromised status of discounting for time preference at a constant rate can perhaps be best illustrated by the following example. Consider an exceedingly simple economy with 100 units of re sources. Two individuals, with identical utility functions, live in this economy: one from year 1 to year 50 and the other from year 51 to year 100. There is no possibility for productive activity; thus, the individuals will be able to derive utility only from the existing 100 units of resources. [280]

In the absence of discounting for time preference, each individual would be allocated 50 units of resources. In the face of a positive rate of time preference, however, even a relatively modest one, the first individual would get the bulk of the resources. It would be difficult to construct an attractive ethical theory that privileged the first individual in this manner merely because she lived 50 years earlier than the second individual.

The possible justifications for discounting for time preference at a positive rate are not compelling. First, one might posit that if discounting for time is appropriate intragenerationally, it should be acceptable in tergenerationally as well. There is a fundamental difference, however, between the two situations.

Intragenerational discounting affects the timing with which a particular individual decides to expend a fixed amount of resources. It is merely a reflection of the individual's preferences and, as discussed in Part I.H, does not raise any significant ethical questions. [281] In contrast, intergenerational discounting affects the quantity of resources available to each individual.

In an intergenerational context, one must initially decide how to allocate resources to individuals in different generations—a societal decision with ethical underpinnings. Then, each individual must decide how to time the consumption of resources across her lifetime—a personal decision with no ethical ramifications, [282] other than a weak concern about excessive myopia. [283]

Some economic models that purport to analyze intergenerational problems construct their utility function by reference to an individual who lives forever. [284] Models of this type collapse the intergenerational and intragenerational aspects of the optimization across generations. [285] Thus, they overlook an important dimension of the problem. One simply cannot avoid making ethical judgments about intergenerational transfers by mechanically importing to this endeavor the intragenerational framework. [286]

The second possible justification is that time discounting does not show lesser regard for future generations because even though it under values the interests of a particular generation relative to an earlier generation, it overvalues its interests relative to a later one. According to this claim, each generation is treated in a comparable way: somewhat worse than its predecessors and somewhat better than its successors.

The claim is not an affirmative argument for discounting. Instead, its ambition is far narrower: it merely responds to one possible argument against discounting. It does not carry the day, however, even in this limited respect. Absent economic growth, as would be the case for example in economies with high levels of consumption, constant discounting for time preference would lead to the progressive impoverishment of subsequent generations. Given the choice between consuming resources in the present and leaving them for future generations one would choose the former because the utilities derived from these resources by later generations would be heavily discounted.

It is true that if discounting actually threatened to impoverish future generations additional resources would be allocated to these generations as a result of the declining marginal utility of consumption, which would make the poorer generations value a unit of consumption more. This phenomenon, which is a feature of growth discounting at a negative rate of growth, could mitigate some of the harshness that would otherwise result. The existence of such a safety valve, however, is hardly a ringing endorsement of discounting for the pure rate of time preference.

Yet another argument for discounting for time preference focuses on the greater affinity that the current generation feels for itself and for the generations that immediately follow it. As Kenneth Arrow and several co-authors note, the rate of time preference "may represent discounting for empathetic distance (because we may feel greater affinity for generations closer to us)." [287] By its terms, the statement purports to make a descriptive claim rather than a normative judgment: it does not explain why a social welfare function that reflects such judgments is ethically defensible. [288]

Moreover, this argument for discounting is suspect even as a descriptive claim, as the empirical evidence discussed in Part II.B shows quite clearly. [289] It is plausible that we would like to favor ourselves over future generations, and that with respect to future generations we would like to privilege the generations of our children and grandchildren, and per haps even great-grandchildren, over subsequent generations. [290] But discounting at a constant rate implies that our decreasing regard for subsequent generations continues forever. For example, it seems unlikely that, on this account, we would value the loss of one billion lives 1000 years no more than the loss of one life 500 years from now, as would be the case if we used a discount rate of 5 percent. [291]

Other commentators justify discounting by reference to the probability that some catastrophe in the future will result in the destruction of human civilization. [292] The point then is that if we are not sure that a future generation will exist, we should allocate more resources to earlier generations, which are more likely to be around to enjoy the re sources. This argument could well justify discounting at a constant rate, but it is very unlikely that the rate would be more than infinitesimal. [293]

Also embedded in the claim is an ethical issue. To some extent, the survival of humanity is imperiled by actions of our generation, and of a few generations immediately preceding ours. The consequences of nuclear war are one such example. Over the long run, climate change itself may result in a catastrophic scenario. [294] If we are contributing to the probability of humanity's extinction, should we then invoke this possible outcome as an argument to allocate more resources to ourselves? A quite plausible principle is that the current generation should not benefit in this manner from its externalizing behavior.

Finally, time discounting is sometimes justified on the grounds that over time some kind of countermeasures or cures for environmental problems may be devised. [295] If, indeed, there were a scientific basis to support such an assumption, a welfarist framework would call for reducing the harm by the probability that ultimately the harm will not in fact accrue. To the extent that the harm was potentially a catastrophic one, however, risk aversion would mitigate that reduction. [296] More fundamentally, it would be an exceedingly unusual coincidence if the probability that an environmental problem would self-correct just happened to equal the interest rate on financial instruments for every problem and for every length of time. [297] Thus, in its general formulation, this argument for discounting must be rejected as devoid of any factual basis. [298]

In summary, the arguments for discounting as a result of the pure time preference are not compelling. [299] The confusion surrounding the issue stems, at least in part, from equating intragenerational discounting, which ought not to be considered particularly controversial, [300] with in tergenerational discounting, [301] which raises a different set of issues. [302] To conclude, it is worth noting that even though discounting for time preference is a relatively standard technique in economics, there is a long and respectable tradition, traced to an article published in 1926 by Frank Ramsey, that rejects such discounting in intergenerational contexts. [303]

2. Growth in Levels of Consumption Over Time.—It is time to turn to the question of discounting as a result of the growth in levels of consumption over time. Recall that the argument in favor of such discounting rests on the predicted additional wealth of future generations and the decreasing marginal utility of consumption. [304] Given these conditions, growth discounting leads to the maximization of the social welfare function. [305]

Before evaluating the argument for such discounting, it is worth pausing to consider the magnitude of what is at stake. As explained above, the discount rate for growth that maximizes social welfare is the product of g, the growth rate of per capita consumption, and [THETA] , the absolute value of the elasticity of marginal utility. Arrow and his co-authors indicate that most empirical estimates of this elasticity place it in the range between one and two; thus they use the mid-point, 1.5, in some of their calculations. [306] With respect to long-term per capita growth, the central estimate of the Intergovernmental Panel on Climate Change placed it at 1.6 percent. [307] Thus, the rate of discount for growth would be 2.4 percent. This amount is far from inconsequential. It implies, for example, that we would be indifferent between saving one life now and 10.7 lives in 100 years, or between saving one life now and 141,247 lives in 500 years.

This type of discounting gives rise to two important concerns. First, to the extent that subsequent generations are wealthier, they will value the benefits of environmental protection more highly. The standard economic models calculate the environmental damage on the basis of the valuation of the current generation: economic growth implies that later generations will have higher valuations. [308] Standard estimates of the benefits of climate change measures include a reduction in the loss of lives. [309] As shown above, the elasticity of this valuation with respect to levels of consumption is approximately one. [310] Thus, this valuation should be expected to rise at the rate of economic growth. [311] Similarly, valuations of environmental amenities and natural resources are closely linked to levels of income, [312] and will rise with rising income. [313] If the valuation of all the components of the damage of climate change in creased at the rate of economic growth, this factor would either completely cancel out any discounting as a result of greater wealth (when [THETA] is equal to one), or greatly reduce the extent of such discounting (when [THETA] is somewhat greater than one).

More fundamentally, the growth discounting account assumes implicitly that the benefits of environmental activities are distributed in the same manner as the costs. Then, because the benefits accrue to individuals who are wealthier than those who bear the costs, the beneficiaries have a lower marginal utility of consumption, and discounting is necessary to maximize social welfare. This implicit assumption is highly questionable. Most studies of the impact of climate change show that the damages will be suffered disproportionately by individuals in poor developing countries: Bangladesh, for example, is likely to be particularly affected by sea level rises. [314] In contrast, the contribution to the global warming problem lies to a large extent with the developed countries, and financial responsibility for mitigation measures will be borne primarily by these countries. [315]

Currently, the United States and Bangladesh have per capita gross national products (GNP) of $26,980 and $240, respectively. [316] The figures differ by a factor of about 112. It is quite unlikely that in 100 years or so Bangladesh and the United States will have the same per capita GNP. Thus, to the extent that the United States is paying for the environ mental measures and Bangladesh is benefiting from them, the kind of growth discounting contemplated in the standard economic models is clearly inapposite. In order to maximize the social welfare function, a lower factor would have to be used to reflect the fact that even when the benefits of climate change measures begin to accrue, Bangladesh will be poorer than the United States.

It is quite possible that even in a hundred years Bangladesh's per capita GNP, in constant dollars, will be lower than the per capita GNP in the United States is now. Then, in order to maximize the social welfare function, one would have to apply a negative discount rate. Such a rate would justify spending more now than the benefits in the future because the benefits in the future would accrue to individuals with lower levels of consumption, and hence higher marginal utilities of consumption.

One might object to this line of argument on the grounds that citizens of the United States have no obligation to improve the lot of Bangladesh. Such a position is certainly debatable, but it resides outside the domain of utilitarianism, where the concept of discounting future utilities has its intellectual home. In the example described above, where in constant dollars the per capita GNP in Bangladesh in 100 years is lower than the current per capita GNP in the United States, a negative discount rate does maximize the social welfare function and is the policy that should be chosen on utilitarian grounds.

This discussion points to an obvious anomaly. If we are prepared to be serious about utilitarianism in the intergenerational context, why do we not take it seriously in the intragenerational context? Doing so would imply a large increase in the aid from developed to developing countries, where the marginal utility of consumption is far higher as a result of the much lower per capita GNP.

One can, to be sure, construct a plausible ethical theory under which greater current foreign aid is not compelled but mitigation measures for climate change are. The depressed economic status of developing countries might not be the direct consequence of any actions by the developed countries, although the issue is not uncontroversial. In contrast, any damages that might affect developing countries as a result of climate changes are caused to a large degree by energy consumption patterns in the developed countries. [317] So, the developed countries might have an obligation to mitigate a problem that they caused and yet not have a similar obligation to reduce a level of inequality that they did not cause.

It is difficult, however, to reconcile such an ethical theory with welfarist approaches. Whether the lower level of per capita GNP in developing countries is caused by climate change or not, it still results in a higher marginal utility of consumption. If the purpose is to transfer re sources to where they will produce the greatest increase in utility, the cause of the inequality simply does not matter. Moreover, the selective rejection of utilitarianism to justify the current low levels of foreign aid would call into question its selective invocation to justify discounting in some fashion the benefits to future generations of environmental measures. [318]

Alternatively, one might argue that utilitarianism calls for maximizing only the aggregate social welfare function of the relevant polity. With respect to the analysis of foreign aid, the relevant polity might be each individual nation. Foreign aid would then be justified only to the extent that donors in a wealthy country derive utility from helping recipients in a poorer country, not on the basis of the utility derived by the recipients.

In the context of climate change, given the global nature of the problem, it would be paradoxical to decide on a nation's obligations merely by reference to that nation's aggregate social welfare function. Indeed, the standard economic formulation of discounting aggregates across a global social welfare function and no commentator that I am aware of argues for a more constrained view. Perhaps one could construct a defensible theory under which the relevant polity changed with the nature of the problem, but it could not be derived solely from utilitarian principles and would have to be grounded on some nonconsequentialist ethical norm.

Growth discounting also inappropriately merges the decision concerning the desirability of a project with distributional considerations. Under cost-benefit analysis, projects are undertaken based on the aggregate willingness-to-pay of the beneficiaries. Because the government undertakes large numbers of projects and regulatory initiatives, the losers with respect to one governmental intervention may well become winners with respect to another. It therefore does not make sense to suffer social welfare losses with respect to an individual project simply to obtain a more desirable distribution of resources.

After aggregating all projects, however, the set of policies that maximizes net social welfare across the population as a whole might impose significant net costs on a subset of the population. To the extent that such inequities persist, the government can effect redistribution intragenerationally through the income tax system. Such an approach generally gives rise to fewer distortions and is therefore more desirable than compromising the social welfare consequences of individual projects. [319]

In contrast, under growth discounting, the amount invested in an environmental project will be less than that justified by reference to the aggregate willingness-to-pay of the beneficiaries. Thus, the efficiency of each individual project would be compromised in order to effect redistribution.

It is true, of course, that intergenerational redistribution is more difficult to achieve than its intragenerational counterpart. For example, if we allocate more to the current generation in order to improve the aggregate social welfare but feel that such a policy imposes net costs on future generations, there is no easy means to compensate future generations. In theory, we could tax ourselves to create a trust fund that future generations could tap into at predetermined times, but there is a high likelihood that the money would become an attractive target in the future for our generation, or for intervening generations. Thus, the durability of the arrangement over the long-term could not be assured.

A different problem would arise if social welfare were to be maximized by allocating resources to future generations in a manner that imposed unacceptably high net costs on the current generation—the phenomenon that underlies the growth discounting approach. There is no obviously desirable mechanism by which we could tax future generations in order to compensate ourselves. [320] While we could

consume suboptimally high levels of renewable and nonrenewable resources, such consumption imperils social welfare in a way that is avoided by redistribution through the tax system. A better alternative is to finance measures that benefit the current generation through long-term debt, the burden of which would eventually fall on future generations.

These difficulties suggest that the benefits of intragenerational redistribution through the tax system will not be fully available intergenerationally. Nonetheless, these difficulties do not necessarily call for conflating the resource allocation and distribution inquiries, as growth discounting does. Instead, one needs to ascertain, as one typically does in the intragenerational context, whether bifurcating the inquiry and per forming the redistribution through a different mechanism would reduce undesirable distortions.

D. Role of Opportunity Costs

My argument should not be read to imply that discounting has no role to play in the intergenerational context. For example, consider a harm that could be averted either now or in the future. In this scenario, assume that if the problem were addressed in the future, funds could be invested now in other projects and then transferred at a later time to avert the harm. The most that it would be worth paying to avert the future harm now is the present discounted value, at the rate of return generated by these alternative projects, of the amount that would be needed if the problem were addressed in the future. Regardless of the nature of our obligation to future generations, it makes no sense to spend more when we can achieve the same result for less.

A similar result could attach even to an irreversible environmental problem. Consider an environmental harm that can be remedied only through a current expenditure: if the problem is not addressed now, it cannot be successfully addressed in the future. Even if the objective were to transfer resources to a future generation, it might nonetheless be preferable to leave the problem unattended if alternative investments would yield a higher rate of return. Then, the future generation would have to face the environmental harm but would enjoy, for example, the fruits of greater investments in technological innovation. [321]

The substitutability of environmental and non-environmental benefits can be seen most clearly from the vantage point of a utilitarian perspective. The utilitarian objective is to deploy society's resources in whatever way increases aggregate utility by the largest amount, not to prevent specific environmental harms. Suppose that aggregate utility would increase by transferring current resources to a future generation. If a given investment of resources would yield a larger return in a non-environmental project, the utilitarian calculus would favor this investment over an environmental investment yielding a lower return.

One might conclude at first glance that my disagreement with advocates of discounting the utilities of future generations is only semantic. It might appear, indeed, that taking account of opportunity costs in deciding whether to undertake environmental projects for the benefit of future generations leads to the same results as discounting the utilities of those generations.

Indeed, consider the following two procedures. Under the first procedure, one undertakes any project for which the current cost (in fore gone utility for the current generation) is greater than the present discounted value of the utilities of the future generation that the project is intended to benefit. Under the second procedure, one does not discount the utilities of future generations, but undertakes the project only if the rate of return of the investment is greater than the rate of return of alter native investments (otherwise, even if resources are worth transferring into the future, the alternative investments will be preferable).

As is almost self-evident, these two procedures will yield the same results in certain cases. These procedures, however, are conceptually different and can yield different results in other cases.

Most importantly, discounting the utilities of future generations is a means for determining our obligations to those generations. It is the objective function of a specific ethical theory. In contrast, paying attention to opportunity costs does not imply the choice of any particular theory. It is simply a way of ensuring that society furthers its chosen theory, whatever that theory may be, in the most cost-effective way possible.

For example, suppose that a societal goal is in fact to prevent certain types of irreversible environmental harms, as may be the case under formulations of the principle of sustainable development. [322] We would still defer expenditures for environmental projects if alternative uses of the funds could have a higher rate of return over a given period. But at the point at which such a harm was about to become irreversible, we would undertake the environmental expenditure to prevent this out-

come regardless of the rate of return on other projects. Moreover, in deciding how long to delay the expenditure, one would have to consider whether funds invested in other projects could easily be transferred at a later time to the environmental project. [323] In contrast, if the social objective were to maximize a discounted social welfare function, the expenditure would never be undertaken if the present discounted value of the benefits was lower than the costs.

Similarly, under a corrective justice approach, countries responsible for environmental degradation would have an obligation to mitigate the adverse effects of such degradation. It would nonetheless be appropriate to delay expenditures if alternative interim investments were to yield a higher rate of return. But, at some point, the mitigation would have to be tackled. In contrast, the approach of discounting the utilities of future generations could provide a different prescription altogether.

E. Intergenerational Obligations and Sustainable Development

There is virtual agreement that the central function of the principle of sustainable development is to guide intergenerational allocations. [324] Because this principle is strongly endorsed in international environmental law agreements, [325] it is important to ascertain the extent to which it sets forth an attractive theory of intergenerational obligations. [326]

Before turning to this task, however, one must at least attempt to convert what is still quite an amorphous concept, which suffers from the lack of a uniform definition, [327] into a tool that can actually guide decisions. The starting point to most discussions in this area is the language in Our Common Future, the 1987 report of the World Commission on Environment and Development (often referred to as the Brundtland Re port, after its chair, the then Prime Minister of Norway). [328] This report defines sustainable development as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs." [329] This statement, however, leaves open wide room for disagreement.

Perhaps the two most influential perspectives on what obligations to future generations are encompassed by the principle of sustainable development are those of Edith Brown Weiss and Robert Solow, which are rooted in the traditions of international law and of economics, respectively. [330]

Weiss equates sustainable development with intergenerational equity, which she defines by reference to three principles. [331] First, the principle of conservation of options requires each generation to preserve the natural and cultural resource bases so that the options available to future generations are not unduly restricted. Second, the principle of conservation of quality requires each generation to prevent a worsening of the planet's environmental quality. Third, the principle of conservation of access requires each generation to provide its members with equitable rights of access to the legacy of past generations, and to conserve this access for the benefit of future generations. [332]

In contrast, according to Solow, sustainability requires that each future generation have the means to be as well off as its predecessors. He gives content to this principle by proposing a modification to the traditional measure of a nation's economic activity. From Net National Product (NNP)—Gross Domestic Product (GDP) minus the depreciation of fixed capital assets—he would subtract the value of expended nonrenewable resources and environmental assets like clean air and water. [333] Solow argues that each generation must use its nonrenewable and environmental resources in a way that does not detract from the ability of future generations to have a similar standard of living. [334] He admits that certain unique and irreplaceable resources, like certain national parks, should be preserved for their own sake, [335] but maintains that the consumption of non-unique natural and environmental resources ought to be permissible as long as they are replaced by other resources such as equipment or technological knowledge.

The two formulations share important characteristics. First, they define the primary obligation to future generations in terms of a constraint that specifies how much must be left to a subsequent generation. [336] Second, Weiss and Solow would both allow some level of destruction of most natural resources, as long as future generations are compensated in an other way, such as by technological development. [337] Third, they both regard certain natural resources as irreplaceable and would require that such resources be protected for subsequent generations. [338]

In essence, then, under both formulations, every generation must provide the subsequent generation with the means to do at least as well as it did. So, for example, sustainable development would be consistent with the current generation seeking to maximize its own utility, as long as this maximization is subject to a constraint resulting from the need to leave sufficient resources to future generations.

There are, of course, daunting challenges ahead in providing further specificity to the principle. For example, additional work needs to be done to determine how to

value the increase in knowledge or the negative long-term environmental effects of economic activity. [339]

Also, throughout history, there has been a progressive increase in standards of living. Should the constraint defining one generation's obligation to its successors thus provide for a progressive increase in well-being, so that this pattern may continue? On what basis would that in crease be determined? What would be the ethical underpinnings for such a requirement?

Moreover, the link between sustainable development and population policy is not well articulated. [340] The population in any generation is a function of decisions of prior generations. [341] For example, one might argue that if the current generation's actions were to lead to an increase in population, it would have an obligation to provide additional resources so as not imperil the level of well-being of an average person in the next generation. [342]

Many commentators also believe that the concept of sustainable development contains a precautionary principle, which prescribes that scientific uncertainties be resolved in favor of environmental controls. [343] As discussed above, there is some possibility that catastrophic events would materialize in the future if the climate change problem is left unattended. [344] The precautionary principle would presumably call for avoiding such consequences. In fact, given that technological advances may greatly contribute to the wealth of future generations, it may be that the precautionary principle will do most of the work in justifying climate change expenditures.

Left unanswered in the academic discussions concerning the precautionary principle, however, are important questions about its scope. For example, what probability of a catastrophic event is sufficiently high to trigger the operation of the principle? Similarly, what is a sufficiently harmful consequence? [345] Spending the resources needed to avoid a low-probability, catastrophic outcome might interfere with the ability to make resources available to subsequent generations. How should this tradeoff be resolved?

This background on the scope of the principle of sustainable development is sufficient to permit an evaluation of the extent to which the principle can form the basis for a desirable theory of intergenerational obligations with respect to environmental matters. At a very general level, the principle appropriately underscores that the current generation, which has control of vast decisionmaking authority concerning the resources that will be available in the future, should not simply ignore the interests of future generations.

Beyond this level of generality, however, the principle suffers from severe shortcomings. Most importantly, in practice it is likely to impose too limited an obligation on the current generation. Say, for example, that the current generation, for a comparative small sacrifice, can prevent a very large harm to a subsequent generation. Perhaps an expenditure of only $1 at the present would lead to averting harm of several hundred billion dollars in 100 years. Even if the future benefit were discounted at a high level, the present discounted value of the benefit would greatly exceed the corresponding cost.

The principle of sustainable development, however, would not require this expenditure if the subsequent generation would, despite the harm, be better off than the current one. Thus, if the next hundred years can be expected to bring sufficiently rapid technological progress, the environmental expenditure would not need to be undertaken. In fact, because the rate of technological progress is currently so high, the principle of sustainable development could in fact remove from the current generation any obligation to undertake environmental measures for the benefit of future generations.

Conversely, while this issue is of less direct practical importance, the principle of sustainable development could, in theory, demand excessive sacrifice from the current generation. Say, for example, that absent some intervention, the generation living 100 years from now would be $1 poorer than the current generation, and that for an expenditure of several hundred billion we could confer upon that generation an extra $1. The principle of sustainable development would require the expenditure, despite the obvious waste in resources. [346]

These shortcomings of the principle of sustainable development serve to underscore the relative attractiveness of utilitarian approaches. Consistent with such approaches, in an intragenerational context, the social decisionmaker would seek first to undertake all projects that have desirable cost-benefit ratios. Then, if the resulting distribution of re sources was unattractive, the social decisionmaker would require redistribution. In a utilitarian framework, redistribution is justified as a result of the fact that poorer individuals have a higher marginal utility of consumption; total utility is therefore increased by redistributing from rich to poor. [347]

The costs of effecting redistribution (whether in the form of transaction costs or perverse incentives) play an important role in determining how much redistribution is socially desirable. Indeed, sufficiently high costs could dominate the benefits that would come from transferring re sources from wealthier individuals, with a lower marginal utility of consumption, to their poorer counterparts.

In an intergenerational context, the inquiry could be essentially the same: pick projects with good cost-benefit ratios and redistribute as guided by reference to the relative marginal utilities of consumption and by the costs of effecting redistribution. In contrast, the principle of sustainable development requires expenditures with unattractive cost-benefit ratios, fails to require expenditures with attractive cost-benefit ratios, and is oblivious to the costs of effecting redistribution.

F. Toward a Theory of Intergenerational Obligations

The articulation of a complete theory of intergenerational obligations with respect to environmental matters is beyond the scope of this Article. Nonetheless, the preceding discussion can be crystallized into a set of principles setting forth the backbone for such a theory.

First, the mechanical importation of discounting for time preference at the rate used intragenerationally is wholly unjustified: how one individual decides to time her expenditure of a fixed set of resources over her lifetime is a fundamentally different question from how society allocates a given set of resources among individuals in different generations. [348] Intergenerationally, discounting for time preference unjustifiably undervalues the interests of future generations.

Second, discounting for economic growth is also fraught with problems. Most importantly, the formula used in the standard economic models ignores the fact that the primary contributors to international environmental measures are far wealthier than the primary beneficiaries of such measures. In fact, even in the future, when the benefits of measures undertaken now actually accrue, these beneficiaries are likely to be poorer than the contributors to such measures are now. Under these circumstances, any positive discounting for economic growth would be inappropriate. To the contrary, given the decreasing marginal utility of consumption, a utilitarian framework would call for environmentally protective measures even if the current costs are somewhat greater than the future benefits. [349]

Third, a theory of intergenerational obligation must play close attention to opportunity costs. Even though it is inappropriate to discount the utility functions of future generations, it does not make sense to under take environmental expenditures for the benefit of future generations if the investment can yield higher benefits elsewhere, and if no ethical obligations are compromised by delaying expenditures.

Fourth, consistent with the principle of sustainable development, [350] an attractive theory of intergenerational obligations should seek to prevent catastrophic harms and the destruction of unique natural resources. Admittedly, however, the dividing line between the use of everyday renewable and nonrenewable natural resources, and the destruction of unique resources may be hard to draw in particular circumstances.

Fifth, proper attention needs to be given to distributional issues. As in the intragenerational context, one should not compromise the efficiency of a particular environmental policy in the name of distributional concerns, but one should be prepared to redistribute if the aggregate effects of such policies lead to unattractive distributional outcomes. In the intergenerational context, the mechanisms for redistribution are more cumbersome, [351] but the issue nonetheless merits attention.

Sixth, an attractive theory of intergenerational obligations is likely to contain a corrective justice component. Within a traditional utilitarian framework, one cannot explain the moral intuition that industrialized nations have a responsibility to mitigate the adverse effects of climate change, but not to effect massive current redistributions of wealth to poorer countries. [352] To the extent that the current pattern of expenditures and concern on the part of industrialized countries derives from a moral intuition concerning differential levels of responsibility for the two situations, [353] this intuition should be an element of a theory of intergenerational obligations.

Conclusion

This Article shows that the lack of a proper understanding of discounting has led to bad regulatory decisions in the case of latent harms and to an undesirable skewing of the debate in the case of harms to future generations.

If two individuals of the same age are exposed to a latent harm from an environmental carcinogen and to a risk of instantaneous death, respectively, the person exposed to the carcinogen stands to lose fewer life-years and to lose them later in life. Discounting is an appropriate technique for taking account of the latter factor. The use of discounting, however, will lead to misleadingly low valuations of life unless

it is coupled with significant upward adjustments to account for the dread and involuntary nature of environmental carcinogens, as well as for higher income levels of the victims. Unfortunately, the regulatory regime has failed to recognize the need for such adjustments.

With respect to harms to future generations, the Article shows that the use of discounting is ethically unjustified. It privileges the interests of the current generation without a defensible foundation.

The misguided approach to discounting in the two contexts may be attributable in part to a fairly generalized failure to take proper account of the differences between the cases of latent harms and harms to future generations. For the former, discounting raises no significant ethical objections that are independent of those that could be raised against cost-benefit analysis in general and the valuation of human lives in particular. For the latter, in contrast, discounting gives rise to daunting ethical issues.

This Article aims to effect two important public policy changes. With respect to latent harms, it seeks to provide an impetus for correcting the substantial undervaluation of environmental benefits that comes from the regulatory system's approach of mechanically taking valuations of life from the workplace setting and discounting them at an artificially high rate, without performing any of the necessary upward adjustments. With respect to harms to future generations, it seeks to move the debate away from discounting and toward more attractive alternatives.

FOOTNOTES

1. Exec. Order No. 12,866, 3 C.F.R. 1993, p.638, reprinted in 5 U.S.C. 601 (1994). This order replaced a similar Executive Order, promulgated by President Reagan. See Exec. Order No. 12,291, 3 C.F.R. 1981, p.127, formerly in 5 U.S.C. 601. Given its legal status, however, it cannot displace contrary statutory provisions.

For discussion of the practice of OMB review, see Environmental Policy Under Reagan's Executive Order: The Role of Benefit-Cost Analysis (V. Kerry Smith ed., 1984); Thomas O. McGarity, Reinventing Rationality: The Role of Regulatory Analysis in the Federal Bureaucracy (1991); Richard H. Pildes & Cass R. Sunstein, Reinventing the Regulatory State, 62 U. Chi. L. Rev. 1 (1995).

2. Currently, a bill sponsored by Senator Carl M. Levin, Democrat of Michigan, which enjoys bipartisan co-sponsorship, is pending before the Senate. S. 746, 106th Cong. (1999). It mandates the preparation of a cost-benefit analysis for major rules. See id. 623(b)(2). The bill does not preclude an agency from promulgating regulations that fail a cost-benefit test but imposes seemingly tough hurdles to such regulations. See id. 623(d)(2). Legislative efforts to require that essentially all important regulations satisfy a cost-benefit test, began in earnest with the 104th Congress "Contract with America." See Cass R. Sunstein, Congress, Constitutional Moments, and the Cost-Benefit State, 48 Stan. L. Rev. 247 (1996); see infra text accompanying notes 56–58 (views of Senator Leahy on S. 343). The House passed a bill during the Congress' second month, Sunstein, supra, at 275–76, but a companion bill in the Senate failed to move forward when cloture was defeated, id. at 277–82.

3. For example, Richard Morgenstern explains: "The value of fatality risk reduction figures prominently in assessment of environmental benefits. In the case of air pollution, the reduced risk of death often accounts for the largest single component of the dollar value of environmental benefits." Richard D. Morgenstern, Conducting an Economic Analysis: Rationale, Issues, and Requirements, in Economic Analyses at EPA: Assessing Regulatory Impact 25, 41–42 (Richard D. Morgenstern, ed., 1997); see James K. Hammitt, Stratospheric-Ozone Depletion, in id. at 131, 151–52 (value of averted skin cancer mortality comprises 98 percent of the benefits of the regulations implementing the Montreal Protocol). More generally, for all health-and-safety regulations, one recent estimate is that "about 60 percent of the total benefits results from reduction in the risk of death, disease, and injury." Robert W. Hahn, Regulatory Reform: What Do the Government's Numbers Tell Us?, in Risks, Costs, and Lives Saved: Getting Better Results from Regulation 208, 219 (Robert W. Hahn ed., 1996).

Moreover, even in cases in which there are other benefits, EPA's calculation of the magnitude of the benefits focuses on human health effects. See Lisa Heinzerling, Reductionist Regulatory Reform, 8 Fordham Envtl. L.J. 459, 461–62 (1997). For examples, see id. at 495 (asbestos ban); Ronnie Levin, Lead in Drinking Water, in Economic Analyses at EPA, supra, at 205, 227 (corrosion control). The same failure to quantify benefits other than those related to human health effects and mortality are also present with regard to agricultural pesticides, worker protection and primary air quality standards for ozone depletion. Louis P. True Jr., Agricultural Pesticides and Worker Protection 303, 318. However misguided such a policy might be, it magnifies the importance of the discounting issues analyzed in this Article.

4. See Thomas O. McGarity & Sidney A. Shapiro, OSHA's Critics and Regulatory Reform, 31 Wake Forest L. Rev. 587, 629 (1996) (discussing occupational safety).

5. Compare Emmett B. Keeler & Shan Cretin, Discounting of Life-Saving and Other Nonmonetary Effects, 29 Mgmt. Sci. 300, 303–05 (1983) (favoring discounting), I. Steven Udvarhelyi et al., Cost-Effectiveness and Cost-Benefit Analyses in the Medical Literature, 116 Annals Internal Med. 238, 239 (1992) (same), and Milton C. Weinstein & William B. Stason, Foundations of Cost-Effectiveness Analysis for Health and Medical Practices, 296 New Engl. J. Med. 716, 719–20 (1977) (same) with Alan L. Hillman & Myoung S. Kim, Economic Decision Making in Healthcare: A Standard Approach to Discounting Health Outcomes, 7 PharmacoEconomics 198, 198 (1995) (rejecting automatic discounting but arguing for "thoughtful adjustments" to reflect

period of latency) and Michael Parsonage & Henry Neuburger, Discounting and Health Benefits, 1 Health Econ. 71 (1992) (opposing discounting).

For discussion of different methods for discounting the benefits of medical interventions, see Magnus Johannesson, On the Discounting of Gained Life-Years in Cost-Effectiveness Analysis, 8 Int'l J. Tech. Assessment in Health Care 359 (1992).

6. See, e.g., U.S. Office of Management and Budget, Regulatory Program of the U.S. Government, April 1, 1991-March 31, 1992, at 147–48 (1991); Susan W. Putnam & John D. Graham, Chemicals Versus Microbials in Drinking Water: A Decision Sciences Perspective, J. Am. Water Works Ass'n, March 1993, at 57, 60; W. Kip Viscusi, Equivalent Frames of Reference for Judging Risk Regulation Policies, 3 N.Y.U. Envtl. L. J. 431, 436 (1995); infra notes 28–55 (discussing Corrosion Proof Fittings case).

7. See Michael B. Gerrard, Demons and Angels in Hazardous Waste Regulation: Are Justice, Efficiency, and Democracy Reconcilable?, 92 Nw. L. Rev. 706, 743 (1998) ("[The] protection of future generations is not merely a matter for accountants. The Constitution was adopted in part to 'secure the Blessings of Liberty to ourselves and our Posterity.'"); Lisa Heinzerling, Regulatory Costs of Mythic Proportions, 107 Yale L.J. 1981, 2044 (1998) ("the decision to discount lives saved in the future involves a choice about values, as to which reasonable people may disagree"); A. Dan Tarlock, Now, Think Again About Adaptation, 9 Ariz. J. Int'l & Comp. L. 169, 173 (1992) ("Speculation about discount rates becomes a disguised debate about our ethical duties toward future generations.").

8. See Gerrard, supra note 7, at 742–43 ("If a human life is considered to be worth $8 million, and a 10 percent discount rate is chosen, then the present value of saving a life one hundred years from now is only $581. . . . Neither I nor anyone else uses this kind of argument. . . ."); McGarity & Shapiro, supra note 4, at 629 ("The practice of discounting future benefits to present value . . . biases cost-benefit analysis against future generations. A high discount rate clearly biases the analysis against future benefits, even though 'it is not clear why the later-born should have to pay interest to induce their predecessors not to exhaust [depletable resources.]'").

9. The government of the United Kingdom, for example, has rejected the concept of discounting in connection with the health benefits of medical interventions. See Hillman & Kim, supra note 5, at 198.

10. See What Price Posterity?, Economist, Mar. 23, 1991, at 73.

11. See John K. Horowitz & Richard T. Carson, Discounting Statistical Lives, 3 J. Risk & Uncertainty 403, 412 n.2 (1990).

12. See Al Gore, Earth in the Balance: Ecology and the Human Spirit 190–91 (1992). Gore takes a negative view toward discounting:

The accepted formulas of conventional economic analysis contain short-sighted and arguably illogical assumptions about what is valuable in the future as opposed to the present; specifically, the standard 'discount rate' that assesses cost and benefit flows resulting from the use or development of natural resources routinely assumes that all resources belong to the present generation. . . . In the words of Herman Daly, "There is something fundamentally wrong in treating the earth as if it were a business in liquidation."

Id.

13. See, e.g., Peter S. Burton, Intertemporal Preferences and Intergenerational Equity Considerations in Optimal Resource Harvesting, 24 J. Envtl. Econ. & Mgmt. 119, 119 (1993) ("Standard discounting practices confuse two issues: (1) intertemporal discount rates of members of the society and (2) intergenerational equity considerations."); Harold P. Green, Legal Aspects of Intergenerational Equity Issues, in Equity Issues in Radioactive Waste Management 189, 192 (Roger E. Kasperson ed. 1983) (noting that most of the statutes governing conservation of land and water resources and wildlife preservation "do not distinguish between benefits accruing in the short-term future to members of the current generation and longer-term benefits to future generations"); Heinzerling, supra note 7, at 2043–56 (not distinguishing the analysis of carcinogenic risks to the current generation and of risks to future generations); Magnus Johannesson & Per-Olov Johansson, The Discounting of Lives Saved in Future Generations: Some Empirical Results, 5 Health Econ. 329, 329 (1996); Putnam & Graham, supra note 6, at 60 (equating delays in the adoption of public health problems with burdens on future generations).

14. See infra text accompanying notes 28–55 (providing more detailed analysis of the proceedings).

15. See Exec. Order 12,866, supra note 1, 2(b), 6(b) (responsibilities of OMB's Office of Information and Regulatory Affairs (OIRA)).

16. See infra text accompanying notes 32–38.

17. See Corrosion Proof Fittings v. EPA, 947 F.2d 1201, 1218–19 (5th Cir. 1991).

18. See Heinzerling, supra note 7.

19. See id. at 1984–85. Heinzerling does not ultimately take a position on the propriety of discounting. See id. at 2055–56 ("More case-by-case attention needs to be given to the question of whether the future benefits of health and environmental regulation should be discounted at all, and if so, at what rate."). In passing, however, she makes arguments that reveal a deep animosity toward discounting. See id. at 2043–54. The legal literature contains one other sustained discussion on the discounting of environmental benefits. See Daniel A. Farber & Paul A. Hemmersbaugh, The Shadow of the Future: Discount Rates, Later Generations, and the Environment, 46 Vand. L. Rev. 267 (1993). The authors urge that, both intra-and intergenerationally, benefits should be discounted at the long-term real rate of return on riskless investments, which they take to be "in the neighborhood of 1 percent." See id. at 280, 303–04.

20. See Christopher D. Stone, Beyond Rio: "Insuring" Against Global Warming, 86 Am. J. Int'l L. 445, 476 (1992) ("Any variations in policy that might be implied from defensible attitudes toward risk may well be swamped by the implications of defensible discount rates, and, indeed, of how one resolves the philosophical conundrums of valuing the welfare of future generations."); Tarlock, supra note 7, at 173 ("The selection of the [discount] rate determines the strategy.").

21. Derek Parfit, Reasons and Persons 357 (1984). For other examples, see Gerrard, supra note 7, at 742–43 ("If a human life is considered to be worth $8 million and a 10 percent discount rate is chosen, then the present value of saving a life one hundred years from now is only $581."); McGarity & Shapiro, supra note 4, at 629 ("At a discount rate of 10 percent, a dollar's worth of benefits 50 years from now is worth slightly less than a penny today.").

22. Clifford S. Russell, "Discounting Human Life" (Or, the Anatomy of a Moral-Economic Issue), Resources, Winter 1986, at 8, 8; see Frank S. Arnold, Economic Analysis of Environmental Policy and Regulation 193 (1995) ("When the delay between the present and the time the benefits of a regulatory action are enjoyed is very large, say hundreds of years, using virtually any positive discount rate will render the present value of the benefits almost nil."); Robert C. Lind, Reassessing the Government's Discount Rate Policy in Light of New Theory and Data in an Economy with a High Degree of Capital Mobility, 18 J. Envtl. Econ. & Mgmt. S–8, S–20 (1990). ("The basic arithmetic of exponential growth applied in a cost-benefit analysis implies that, regardless of how small the cost today of preventing an environmental catastrophe that will eventually wipe out the entire economy, it would not be worth this cost to the present generation if the benefits in the future are sufficiently distant.").

23. See supra text accompanying note 13.

24. See, e.g., Environmental Policy Under Reagan's Executive Order, supra note 1; McGarity, supra note 1, at 29–59, 174–76, 239–61; Pildes & Sunstein, supra note 1; Sunstein, supra note 2.

25. See supra text accompanying notes 1–4.

26. See infra Part I.G.

27. A similar set of issues arises where current expenditures can prevent future harms to individuals now alive, even though the harm is not a latent disease. The analysis in Part I is therefore relevant to this situation as well.

28. 947 F.2d 1201 (5th Cir. 1991); see Russell, supra note 22, at 9 (noting that before this proceeding, "'discounting of human lives' had not yet become an issue in the public debate"). For discussion of the case, see Rita L. Wecker, Case Comment: A "Hard Look" at a Soft Analysis, Corrosion Proof Fittings v. Environmental Protection Agency, 4 B.U. Pub. Int. L.J. 145 (1994).

29. 51 Fed. Reg. 3738 (1986).

30. See supra text accompanying notes 1–4.

31. See Letter of Robert P. Bedell, Deputy Administrator, Office of Information and Regulatory Affairs to A. James Barnes, Acting Deputy Administrator, Environmental Protection Agency (March 27, 1985), reprinted in Peter S. Menell & Richard B. Stewart, Environmental Law and Policy 104 (1994).

32. See id.

33. See infra text accompanying note 182.

34. See Letter of Robert P. Bedell, supra note 31, at 104.

35. Subcomm. on Oversight and Investigations of the House Comm. on Energy and Commerce, EPA's Asbestos Regulations: Report on a Case Study on OMB Interference in Agency Rulemaking, reprinted in Menell & Stewart, supra note 31, at 111. The Barnes comment does not deal specifically with the problem of latent harms, but it reflects a general antipathy to discounting the valuations of human life.

36. Some Members of Congress took a strident position against discounting. For example, Representative Bob Eckhardt noted that "'it was difficult to say whether that kind of approach was more callous or more foolish'" and Representative James Florio called OMB's approach "ghoulish[]." See Russell, supra note 22, at 9.

37. See Subcomm. on Oversight and Investigations, supra note 35, reprinted in Menell & Stewart, supra note 31, at 109.

38. See id.

39. See id. at 110; Sidney A. Shapiro & Thomas O. McGarity, Not So Paradoxical: The Rationale for Technology-Based Regulation, 1991 Duke L.J. 729, 735 ("In cases of toxic substance exposure, where the onset of disease can be delayed by as much as 30 years, [discounting] effectively ignores the risk altogether.").

40. Subcomm. on Oversight and Investigations, supra note 35, reprinted in Menell & Stewart, supra note 31, at 111.

41. Id.

42. 51 Fed. Reg. 3738, 3757–59 (1986).

43. See id. at 3748; 54 Fed. Reg. 29,460, 29,487 (1989).

44. 54 Fed. Reg. 29,460, 29,483 (1989).

45. See id. at 29,485.

46. See id.

47. Id. at 29,487.

48. Id.

49. Id.

50. 947 F.2d 1201 (5th Cir. 1991).

51. Id. at 1218. Lisa Heinzerling criticizes the Fifth Circuit's position: "One worries about 'preserving an apples-to-apples comparison,' however, only if one is dealing only with apples. In the asbestos case, the costs were dollars and the benefits were lives. These costs and benefits are the same only if dollars and lives are the same." Heinzerling, supra note 7, at 2053. Both positions overlook an aspect of the problem. The Fifth Circuit misses the fact that the intertemporal choices of individuals do not necessarily reflect discounting at the rates used by financial markets (though in fact empirical studies show no statistically significant differences). See infra Part I.F.1. In turn, Heinzerling's rhetorical device fails to acknowledge that the cost-benefit calculus in the case required the valuation of the life, and that the question whether this amount should be discounted is one that depends on how individuals compare the utilities derived from

living in the present to the utilities derived from living in the future. See infra text accompanying notes 223–224.

52. See Corrosion Proof Fittings, 947 F.2d at 1218–19, 1229–30. The court's analysis revealed confusion. It relied primarily on the following example:

Suppose two workers will be exposed to asbestos in 1995, with worker X subjected to a tiny amount of asbestos that will have no adverse health effects, and worker Y exposed to massive amounts of asbestos that quickly will lead to an asbestos-related disease. Under the EPA's approach, which takes into account only the time of the exposure rather than the time at which any injury manifests itself, both examples would be treated the same.

Id. at 1218. In fact, if worker X would never get cancer, the regulation would have no benefit with respect to this worker. With zero benefits, there would be nothing to discount. What the court might have meant is that if workers X and Y had been exposed to asbestos at the same time, and worker Y was injured before worker X, the EPA would treat both cases in the same way (and presumably the Fifth Circuit would have wanted to treat them differently).

53. Id.

54. For related discussion, see infra text accompanying notes 155–157.

55. See Corrosion Proof Fittings, 947 F.2d at 1218 n.19. For further discussion of discount rates, see infra Part I.F.2.

56. S. 343, 104th Cong. (1995).

57. See id. at 623 ("[no] final rule . . . shall be promulgated unless the agency finds that . . . the potential benefits from the rule . . . justify the potential costs of the rule"); id. at 621–622 (dealing with the preparation of cost-benefit analyses); see generally supra text accompanying notes 1–4 (discussing regulatory reform).

58. S. Rep. No. 104–90, at 153 (1995) (supplemental views of Senator Leahy).

59. The only two sustained treatments of the question of discounting in the legal academic literature were those of Farber & Hemmersbaugh, supra note 19, and Heinzerling, supra note 7. See supra note 19 (discussing their positions). While the economics literature has focused on isolated nuances, it has not taken a broad look at the problem or connected the various strands that are necessary to a sophisticated analysis of the public policy choices.

60. See W. Kip Viscusi, The Valuation of Risks to Life and Health: Guidelines for Policy Analysis, in Benefits Assessment: The State of the Art 193, 193 (Judith D. Bentkover et al. eds., 1986) [hereinafter Viscusi, Valuation]. For a more recent survey, see W. Kip Viscusi, The Value of Risks to Life and Health, 31 J. Econ. Literature 1912 (1993) [hereinafter Viscusi, Value]. The technique is generally traced to Thomas C. Schelling, The Life You Save May Be Your Own, in Problems in Public Expenditure Analysis 127 (Samuel B. Chase, Jr. ed., 1968), and E.J. Mishan, Evaluation of Life and Limb: A Theoretical Approach, 79 J. Pol. Econ. 687, 695–705 (1971).

Before the ascendancy of willingness-to-pay studies, the human capital approach was prevalent. This approach valued life in terms of lost earnings. See Viscusi, Valuation, supra, at 198. The technique is subject to the obvious criticism that earnings provide that "individual well-being goes far beyond its financial implications." Id.; accord W.B. Arthur, The Economics of Risks to Life, 71 Am. Econ. Rev. 54, 54 (1981); Lewis A. Kornhauser, The Value of Life, 38 Clev. St. L. Rev. 209, 212 (1990).

61. See Viscusi, Valuation, supra note 60, at 200.

62. See id. at 199–200.

63. Such workers might also face a higher probability of nonfatal risks. Some studies estimate the portion of the wage differential that is attributable to such non-fatal risks. The residual wage differential is then attributed to fatal risks. See Viscusi, Value, supra note 60, at 1919. Some studies, however, do not separate the wage differential into these two components. See id.

64. For criticism of the approach, see McGarity, supra note 1, at 147–48; Steven Kelman, Cost-Benefit Analysis and Environmental, Safety, and Health Regulation: Ethical and Philosophical Considerations, in Cost-Benefit Analysis and Environmental Regulations: Politics, Ethics, and Methods 137, 143–45 (Daniel Swartzman et al. eds., 1982); J. Paul Leigh, Compensating Wages, Value of a Statistical Life, and Inter-industry Differentials, 28 J. Envtl. Econ. & Mgmt. 83, 94–95 (1995); McGarity & Shapiro, supra note 4, at 628–29.

An alternative methodology consists of surveying individuals and asking them how much they would be willing to pay for a particular risk reduction. See Viscusi, Valuation, supra note 60, at 204–05. The disadvantage of this contingent valuation method is that the responses are to hypothetical situations and have no economic consequences. See V. Kerry Smith & William H. Desvousges, An Empirical Analysis of the Economic Value of Risk Changes, 95 J. Pol. Econ. 89, 93–94 (1987).

65. See Maureen L. Cropper & Frances G. Sussman, Valuing Future Risks to Life, 19 J. Envtl. Econ. & Mgmt. 160, 160 (1990) ("The empirical literature on valuing risks to life has focused almost exclusively on valuing mortality risks that occur today—the risk of accidental death a worker faces during the coming year or the risk of dying this month in an auto accident."); Horowitz & Carson, supra note 11, at 405 ("Virtually all the empirical work on the value of risk reductions has considered risks that occur entirely in the present. . . ."); Shapiro & McGarity, supra note 39, at 734 ("most wage premium studies . . . are based on safety hazards, not health risks"). Of course, to the extent that there is a probability of a non-fatal accident, the resulting morbidity risk could also be measured using a willingness-to-pay approach.

66. See Leigh, supra note 64, at 86–87; Viscusi, Valuation, supra note 60, at 200. Of course, in some cases, industrial accidents result in long-term disability rather than death.

67. One ongoing attempt to derive a willingness-to-pay valuation of human lives threatened by carcinogens is reflected in John R. Lott, Jr. & Richard L. Manning, Have Changing Liability Rules Compensated Workers Twice for Occupational Hazards?: Earnings Premiums and Cancer Risks (June 28, 1998) (manuscript on file with the Columbia Law Review). For a contingent

valuation study inquiring how individuals value risk reductions from hazardous waste sites, see Smith & Desvousges, supra note 64.

68. Both the Occupational Safety and Health Administration (OSHA) and EPA were established in 1970. See Sidney A. Shapiro & Thomas O. McGarity, Reorienting OSHA: Regulatory Alternatives and Legislative Reform, 6 Yale J. on Reg. 1, 1 n.1, 2 n.9 (1989).

69. See Cropper & Sussman, supra note 65, at 166 n.8. Moreover, certain risks may be poorly understood even by experts. See Smith & Desvousges, supra note 64, at 108–09.

70. See Sherwin Rosen, The Quantity and Quality of Life: A Conceptual Framework, in George Tolley et al., Valuing Health for Policy: An Economic Approach 221 (1994).

71. One commentator estimates that "the average age of the workplace accident fatality is about 41" whereas "the average age of the workplace cancer victim is likely to be 55, 65, or even higher." John M. Mendeloff, The Dilemma of Toxic Substance Regulation: How Overregulation Causes Underregulation at OSHA 48 (1988).

72. Additional complications are introduced when the length of the person's life is uncertain. See Rosen, supra note 70, at 236–45. No important insights are lost, however, as a result of this simplification. In practice, of course, an individual who would have died of cancer at the end of the latency period may die earlier of other causes. See Lester B. Lave, The Strategy of Social Regulation: Decision Frameworks for Policy 43 (1981).

73. See Maureen L. Cropper & Paul R. Portney, Discounting and the Evaluation of Lifesaving Programs, 3 J. Risk & Uncertainty 369, 376 (1990).

74. A more complicated situation arises when an individual is exposed to a carcinogen over a long period of time and the harm resulting from the exposure is cumulative.

75. See Cropper & Sussman, supra note 65, at 172–73.

76. See W. Kip Viscusi, Discounting Health Effects for Medical Decisions, in Valuing Health Care: Costs, Benefits, and Effectiveness of Pharmaceuticals and Other Medical Technologies 125, 129 (Frank A. Sloan ed., 1995). In contrast, a nominal rate is used to discount current dollars. The real rate is the nominal rate minus the rate of inflation.

77. See Edith Stokey & Richard Zeckhauser, A Primer for Policy Analysis 161–65 (1978).

78. See infra Part I.F.1.

79. See Cropper & Sussman, supra note 65, at 165–66.

80. See supra text accompanying note 71 (hypothesizing that the worker exposed to the risk of instantaneous death is 40-years old).

81. See Cropper & Portney, supra note 73, at 378 n.12.

82. See Cropper & Sussman, supra note 65, at 172 ("This fact . . . is often ignored in risk-benefit analyses.").

83. See infra Part I.G.

84. See Robert F. Bordley, Making Social Trade-Offs Among Lives, Disabilities, and Cost, 9 J. Risk & Uncertainty 135, 138 (1994).

85. See Cropper & Portney, supra note 73, at 371–72; Rosen, supra note 70, at 222–23.

86. A similar issue arises in the literature on QALYs, or quality-adjusted life years, which are a means for adjusting the utility that an individual gets in a period by the quality of her health in that period. So, for example, an individual derives greater utility from a year in which her health is excellent than in one in which she is disabled. See Richard Zeckhauser & Donald Shepard, Where Now for Saving Lives?, Law & Contemp. Probs., Autumn 1976, at 5, 12–13. In the context of QALYs, separability implies that the utility that a person derives from the quality of her life in a particular year is independent of the qualities of her life in past years. See John Broome, QALYs, 50 J. Pub. Econ. 149, 151–52 (1993).

87. Broome, supra note 86, at 151–52. Broome applies this label to a separability model in the context of QALYs. See supra note 86.

88. See Bordley, supra note 84, at 138.

89. See infra Part I.F.1.

90. See infra Part I.E.3.

91. See supra text accompanying notes 65–69.

92. See Bordley, supra note 84, at 138; Michael J. Moore & W. Kip Viscusi, Discounting Environmental Health Risks: New Evidence and Policy Implications, 18 J. Envtl. Econ. & Mgmt. S–51, S–54 (1990); Rosen, supra note 70, at 224.

93. Donald S. Shepard & Richard J. Zeckhauser, Survival Versus Consumption, 30 Mgmt. Sci. 423, 424 (1984).

94. Id. at 424; see also Joseph Lipscomb, Time Preference for Health in Cost-Effectiveness Analysis, 27 Med. Care S233, S237 (1989) (asking whether individuals evaluate multiperiod health outcomes "in accordance with constant-rate discounting").

95. See W. Kip Viscusi & Michael J. Moore, Rates of Time Preference and Valuations of the Duration of Life, 38 J. Pub. Econ. 297, 297–98 (1989) ("Although money is readily transferable across time, health status is not."). Part I.F.1, infra, explains more generally why discounting health risks is analytically different from discounting financial flows.

96. There have been attempts to estimate the rate at which individuals discount their utilities, but they have been conducted on the basis of constant discounting models. See Moore & Viscusi, supra note 92, at S–54. There also are empirical estimates of how discount rates depend on the period over which the discounting is performed, but these studies are intergenerational, or at the very least interpersonal. See infra Part II.B.

97. See Donald A. Redelmeier & Daniel N. Heller, Time Preference in Medical Decision Making and Cost-Effectiveness Analysis, 13 Med. Decision Making 212, 216 (1993); id. at 214–15 (finding that rates for temporally proximate events were larger than for more distant events); infra Part II.B (same finding in intergenerational models).

98. See supra text accompanying notes 36–38.

99. See Cropper & Portney, supra note 73, at 377.

100. See Shepard & Zeckhauser, supra note 93, at 437 n.18; Viscusi, supra note 76, at 130. But see Glenn Blomquist, Value of Life Saving: Implications of Consumption Activity, 87 J. Pol. Econ. 540, 555 (1979) (finding lower elasticity).

101. See supra text accompanying notes 78–80.

102. See Viscusi, supra note 76, at 130; Richard Zeckhauser, Procedures for Valuing Lives, 23 Pub. Pol'y 419, 437 (1975).

103. See William D. Nordhaus, To Slow or Not to Slow: The Economics of the Greenhouse Effect, 101 Econ. J. 920, 925–26 (1991); Viscusi, supra note 76, at 130.

104. Farber & Hemmersbaugh, supra note 19, state that "the discount rate even for economic benefits cannot significantly exceed the expected long-term rate of economic growth; otherwise, we would discount even the destruction of most future Gross Domestic Product to a low present value over periods of only decades." Id. at 296. The authors appear to be making a pragmatic argument for keeping the effective discount rate low. There is, however, no plausible normative argument for linking the two rates in this manner.

105. U.S. Census Bureau, Historical Income Tables—Persons, Table P–44 (visited June 22, 1998) <http://www.census.gov/hhes/income/histinc/p44.html>.

106. Over the longer run, the rate has been higher. See William R. Cline, The Economics of Global Warming 251 (1992) (estimating that "real per capita income in the United States has grown at about 1.7 percent annually over the past century").

107. See Donald S. Shepard & Richard J. Zeckhauser, Life-Cycle Consumption and Willingness to Pay for Increased Survival, in The Value of Life and Safety 95, 120–27 (M.W. Jones-Lee ed., 1982) [hereinafter Shepard & Zeckhauser, Life-Cycle Consumption]; Shepard & Zeckhauser, supra note 93, at 432–36.

108. See Zeckhauser, supra note 102, at 437.

109. Id. at 438.

110. In general, one's credit suitability for loans is evaluated on the basis of one's present income. There are some exceptions, however, such as student loans to finance post-secondary education.

111. See Shepard & Zeckhauser, Life-Cycle Consumption, supra note 107, at 107–15. There is potentially a logical inconsistency in believing that individuals cannot process the fact that they will have higher incomes in the future in order to value their lives accordingly, but positing that individuals will borrow money in the expectation of higher income in the future.

112. See id. at 125.

113. See id.

114. See id. at 121.

115. See Shepard & Zeckhauser, supra note 93, at 434.

116. See id. at 435 (noting that "the real world lies somewhere in between" the two models).

117. See supra text accompanying note 114.

118. See Shepard & Zeckhauser, supra note 93, at 433.

119. See Viscusi, Value, supra note 60, at 1942–43 ("the population of exposed workers . . . generally have lower incomes than the individuals being protected by broadly based risk regulation").

120. EPA should, however, vary its valuations of life on the basis of the age profile of the affected population, to account for the different numbers of life-years at stake in various regulatory programs.

121. For discussion of environmental justice, see Vicki Been, Coming to the Nuisance or Going to the Barrios? A Longitudinal Analysis of Environmental Justice Claims, 24 Ecology L.Q. 1 (1997); Vicki Been, Locally Undesirable Land Uses in Minority Neighborhoods: Disproportionate Siting or Market Dynamics?, 103 Yale L.J. 1383 (1994); Robert D. Bullard, Anatomy of Environmental Racism and the Environmental Justice Movement, in Confronting Environmental Racism: Voices from the Grassroots 15 (Robert D. Bullard ed., 1993); Richard J. Lazarus, Pursuing "Environmental Justice": The Distributional Effects of Environmental Protection, 87 Nw. U. L. Rev. 787 (1993).

122. An ethical objection to such particularization would be an attack on cost-benefit analysis in general and to the use of a willingness-to-pay methodology for valuing lives in particular. See Guido Calabresi & Philip Bobbitt, Tragic Choices: The Conflicts Society Confronts in the Allocation of Tragically Scarce Resources 32 (1978) (referring to "the external costs—moralisms and the affront to values, for example—of market determinations that say or imply that the value of a life or of some precious activity integral to life is reducible to a money figure"). Nonetheless, using differential valuations of life based on income levels is likely to prove objectionable to some supporters of cost-benefit analysis, and to magnify the objections adduced by opponents of this approach.

123. See U.S. Census Bureau, Historical Income Tables—Persons: Table P–36: Occupation of Longest Job—Workers (Both Sexes Combined) by Median and Mean Earnings (visited June 22, 1998) <http://www.census.gov/hhes/income/ histinc/p36.html>.

124. See id.

125. See id.

126. See Paul Slovic, Perception of Risk, 236 Science 280 (1987).

127. Zeckhauser, supra note 102, at 445 n.27.

128. Cass Sunstein cogently explains that "the question whether a risk is run voluntarily or not is often not a categorical one but instead a matter of degree." Cass R. Sunstein, Bad Deaths, 14 J. Risk & Uncertainty 259, 272 (1997). Sunstein would place risks on a voluntariness/involuntariness continuum based on three factors: whether the worker has adequate information about the risk; whether the worker is compensated for the risk; and whether the compensation package does not appear unfair, even if voluntarily chosen by the parties, as a result of background inequality between the employer and employee. See id.; see also Shapiro & McGarity, supra note 39, at 734 ("Unfortunately, low-paid workers in hazardous industries where there are no (or weak) unions may act more out of desperation than choice.").

129. See Maureen L. Cropper & Uma Subramanian, Public Choice Between Lifesaving Programs 6 (World Bank Policy Research Working Paper 1497, 1995). Of course, if an individual is exposed to a toxic air pollutant, she could move somewhere else. Sunstein would nonetheless classify the risk as involuntary because the individuals are not in a contractual relationship with the producer of the risk and cannot avoid the risk except at great cost, in this case by moving to another area. See Sunstein, supra note 128, at 271.

Moreover, in many cases, individuals may lack sufficient information about environmental risks to make informed choices. Even if they had such information, risks that are uniformly distributed throughout the country could obviously not be avoided by moving elsewhere. For further discussion of the difference between voluntary and involuntary risks, see Richard H. Pildes & Cass R. Sunstein, Democrats and Technocrats, Journees d'Etudes Juridiques Jean Dabin (forthcoming 2000) (manuscript on file with the Columbia Law Review).

130. See supra text accompanying notes 60–62.

131. Even studies of how the price of a house in an area with high concentrations of this pollutant compares to the price of an otherwise similar house in an area with better air quality do not capture the value of involuntary risk. While such hedonic price studies are a commonly used revealed preference tool for economic valuations, see Ronald G. Cummings et al., General Methods for Benefits Assessment, in Benefits Assessment, supra note 60, at 171–76, the participants in these housing markets are individuals attempting to decide where to live. They are making a choice about whether to live in one area rather than another. As a result, it would be a stretch to regard their "choice" as involuntary. Rather, the involuntary label is better used for individuals who have lived in an area for a long time, have strong personal ties to the area, and lack the resources to move.

132. An extensive list of such references is provided in Heinzerling, supra note 7, at 1983 n.1, 2. The genesis for these studies is a table prepared in the 1980's by John Morrall, an OMB official. See John F. Morrall III, A Review of the Record, Regulation, Nov./Dec. 1986, at 25, 30 tbl.4. Heinzerling notes, however, that the regulations with numbers at the high end were never promulgated. Moreover, she argues that the remaining differences would be less stark if Morrall had not discounted the benefits of environmental regulation or reduced the estimates of risk prepared by the agencies. See Heinzerling, supra note 7, at 1984–85.

133. There has been strong criticism to valuations based on survey responses. See Richard B. Stewart, Liability for Natural Resource Injury: Beyond Tort, in Analyzing Superfund: Economics, Science, and Law 219, 234–38 (Richard L. Revesz & Richard B. Stewart eds., 1995). Nonetheless, a panel of distinguished economists, co-chaired by Nobel Prize winners Kenneth Arrow and Robert Solow, which had been empaneled by the National Oceanic and Atmospheric Administration (NOAA), gave qualified endorsement to the use of contingent valuation techniques. See 58 Fed. Reg. 4601, 4610 (1993). Clearly, revealed preference valuations would be preferable, but, as indicated above, such valuations cannot be used for involuntary harms. See supra text accompanying notes 130–131.

134. See Cropper & Subramanian, supra note 129, at 2.

135. See id. at 16–18.

136. See id. at 3–7.

137. The remaining characteristics were the extent to which the affected population was to blame for the risk, the seriousness of the risk, and whether the risks affected respondents personally. In addition to these four risk characteristics, the respondents were also asked to assess four program characteristics: the efficacy of the program, the appropriateness of government intervention, the fairness of the funding mechanism, and the time before the program begins to save lives. See id. at 39.

138. See id. at 40.

139. A labeling program, designating food to be free of pesticide, could work effectively if the claims were in fact truthful and adequate information was conveyed to prospective buyers. But social coordination would be necessary to set up the labeling program and to police its integrity.

140. See Cropper & Subramanian, supra note 129, at 40.

141. See id. at 41.

142. See id. at 48.

143. See id. at 24, 41.

144. See id. at 4–5.

145. See McGarity, supra note 1, at 146–49; Kelman, supra note 64, at 144; Viscusi, Value, supra note 60, at 1928.

This effect is discussed even though it has not been the focus of empirical study, see supra text accompanying notes 99–100, because it flows in part from the difference between the voluntary nature of workplace harms and the involuntary nature of environmental harms.

146. Some self-selection can take place with respect to reasonably local risks, such as those that result from proximity to hazardous waste sites. With respect to more regional risks, such as regional air pollution, however, such self-selection is far more difficult.

147. See Sunstein, supra note 128, at 259.

148. See Tammy O. Teng et al., Five-Hundred Life-Saving Interventions and Their Cost-Effectiveness, 15 Risk Analysis 369 (1995).

149. See id. at 370.

150. See id. at 371.

151. See id.

152. See supra text accompanying notes 131–133.

153. George Tolley et al., State-of-the-Art Health Values, in Tolley et al., supra note 70, at 323, 339–44.

154. See id. at 339–40.

155. See supra text accompanying notes 64–68.

156. But cf. Sunstein, supra note 128, at 269 (an extended period before death can contain benefits, since it allows grief and adjustment).

157. See Tolley et al., supra note 153, at 329–32, 340; supra note 133 and accompanying text.
158. See Tolley et al., supra note 153, at 340.
159. See id. at 340–41; see also Michael W. Jones-Lee et al., The Value of Safety: Results of a National Sample Survey, Econ. J., March 1985, at 49, 58–60. For a more recent study finding a higher willingness-to-pay to avoid carcinogenic harms, see Ian Savage, An Empirical Investigation into the Effect of Psychological Perceptions on the Willingness-to-Pay to Reduce Risk, 6 J. Risk & Uncertainty 75, 77, 85 (1993).
160. For intuitions supporting a higher valuation for dreaded harms, see Mendeloff, supra note 71, at 48; Shapiro & McGarity, supra note 39, at 734 n.29.
161. See Lave, supra note 72, at 44 ("Discounting future health effects at the standard rate makes sense only if there is a fixed transformation rate between dollars and health."); John Mendeloff, Measuring Elusive Benefits: On the Value of Health, 8 J. Health Pol., Pol'y & Law 554, 568 (1983) ("discount rate for health effects should largely be based upon individuals' time preferences"); supra note 51 and accompanying text; infra Part I.F.1. But see Victor R. Fuchs & Richard Zeckhauser, Valuing Health—A "Priceless" Commodity, 77 Am. Econ. Rev. 263, 264 (1987) (suggesting that life years should be discounted in the same manner as cash-flows).
162. See Farber & Hemmersbaugh, supra note 19, at 287.
163. Viscusi, supra note 76, at 131–32.
164. See John A. Cairns, Valuing Future Benefits, 3 Health Econ. 221, 221 (1994) ("Little is known about individual time preferences with respect to future health, and in particular whether they differ from preferences with respect to future wealth."); Putnam & Graham, supra note 6, at 60 ("Instead of choosing a standard discount rate . . . the rate should be based on the . . . preferences of citizens.").
165. See Moore & Viscusi, supra note 92, at S–61 ("One should also be cognizant of the ultimate objective of our study, which is to ascertain whether systematic differences exist between rates of time preference for health and financial rates of return.").
166. See id. at S–52-S–55.
167. See id. at S–53.
168. See id. at S–57. These studies follow a revealed preference approach, which consists of observing the prices at which market transactions take place. See supra text accompanying notes 130–131.
169. See Moore & Viscusi, supra note 92, at S–59, S–61.
170. Id. at S–59; see also supra text accompanying note 55; supra note 76 (discussing difference between real and nominal rates).
171. Moore & Viscusi, supra note 92, at S–61; see also id. at S–52.

It is worth thinking about how the regulatory system ought to react if, contrary to the findings by Moore and Viscusi, one found that individuals discounted health risks at a very high rate, even when they were well informed about these risks. In such situations, it might be appropriate for the government to act in a paternalistic fashion and make social policy on the basis of a lower discount rate. The rationale would be somewhat analogous to the rationale for the usury laws, which prohibit lending at an overly high interest rate.

The utility of an individual with an unusually high discount rate would increase if she were allowed to borrow at a rate up to her discount rate in order to transfer consumption from the future to the present. The usury laws, however, prevent her from doing so because of concern that she might later experience excessive regret. Similarly, in deciding how stringently to regulate future environmental risks, the government could be skeptical of discount rates for health risks that are high compared to the rates at which money gets transferred through the financial markets.

Empirical findings of high discount rates would at the very least be troubling and raise difficult questions as to how social policymakers should react. The Moore and Viscusi studies, showing an equivalence between the rates at which individuals discount health risks and the rates at which the market discounts flows of money, make it unnecessary to face this issue.

172. See id. at S–61. The earlier studies are Michael J. Moore & W. Kip Viscusi, Models for Estimating Discount Rates for Long-Term Health Risks Using Labor Market Data, 3 J. Risk & Uncertainty 381 (1990); Michael J. Moore & W. Kip Viscusi, The Quantity-Adjusted Value of Life, 26 Econ. Inquiry 369 (1988); Viscusi & Moore, supra note 95.
173. See Moore & Viscusi, supra note 92, at S–61.
174. Id.
175. See Viscusi & Moore, supra note 95, at 314.
176. The issue is not entirely free of doubt. For example, a more recent study by Viscusi and a different co-author, using a similar methodology, found real discount rates ranging from 11–17 percent, in the context of automobile safety. See Mark K. Dreyfus & W. Kip Viscusi, Rates of Time Preference and Consumer Valuations of Automobile Safety and Fuel Efficiency, 38 J.L. & Econ. 79, 84, 99 (1995). The authors note that the riskless rate of interest, which they estimate in the 2–5 percent range, is outside the confidence limit of their estimates. See id. at 99. They note, however, that in many cases consumers face interest rates that are far higher than the riskless rate, and that their estimated discount rate was not statistically different, at a 95 percent confidence interval, from the real rates for the financing of automobile purchases (8.5 percent and 11.0 percent for new and used cars, respectively). See id. at 99–100.

Individuals also exhibit inordinately high discount rates with respect to purchases having an effect on energy conservation. Thus, they have not been willing to pay much of a premium on the purchase of products such as air conditioning or heating units in return for lower energy costs in the future. See Jeffrey A. Dubin, Will Mandatory Conservation Promote Energy Efficiency in the Selection of Household Appliance Stocks?, 7 Energy J. 99, 109–13 (1986); Jerry A. Hausman, Individual Discount Rates and the Purchase and Utilization of Energy-Using Durables, 10 Bell J. Econ. 33, 50–52 (1979); Douglas A. Houston, Implicit Discount Rates and the Purchase of Untried, Energy-Saving Durable Goods, 10 J. Consumer Res. 236, 236–37 (1983).

These studies, which are discussed in Dreyfus & Viscusi, supra, at 83–84, affect only financial flows and do not raise the question of how to discount future health risks. The problem here may well be that consumers lack clear information on energy savings benefits or cannot properly process this information if they have it, see Wesley A. Magat & W. Kip Viscusi, Informational Approaches to Regulation 5 (1992), or that they violate some of the postulates of rational theory, see George Loewenstein & Richard H. Thaler, Intertemporal Choice, 3 J. Econ. Persp. 181, 182–83, 192 (1989).

177. See supra text accompanying note 167.

178. See Rosen, supra note 70, at 224; supra text accompanying notes 99–100.

179. In fact, the situation may be even more complicated. Children, for example, may increase one's utility. See Richard A. Epstein, Justice Across Generations, 67 Tex. L. Rev. 1465, 1472 (1989). Then, for a given level of consumption, after one has children one's utility might be higher than before.

180. See supra text accompanying notes 36–38.

181. See Circular No. A–94, 57 Fed. Reg. 53,519 (1992).

182. See Robert C. Lind, Discounting for Time and Risk in Energy Policy 5–6 (1982). For criticisms, see Daniel A. Farber, Risk Regulation in Perspective: Reserve Mining Revisited, 21 Envtl. L. 1321, 1349–50 (1991); Farber & Hemmersbaugh, supra note 19, at 278 & n.43; Viscusi, supra note 76, at 129.

183. See 57 Fed. Reg. at 53,522–23.

184. Id. at 53,523.

185. See id. at 53,520, 53,523.

186. See id. at 53,528 (3.8 percent); 61 Fed. Reg. 6397, 6397 (1996) (3.0 percent); 63 Fed. Reg. 3932, 3933 (1998) (3.8 percent).

187. For clear analyses, see Arnold, supra note 22, at 177–97; Lind, supra note 22. For an excellent primer on discounting, see Lind, supra note 182, at 21–94.

188. Arnold, supra note 22, at 180.

189. See id. at 181.

190. Because income taxes are due on nominal interest, the tax adjustment must be performed first. See id. at 192 n.10.

191. See id. at 192.

192. See id. at 192; Viscusi, supra note 76, at 129, 134.

In 1998, the yield on 30-year Treasury bonds stood at 5.57 percent, the lowest since auctions on these bonds began in 1977. See Guy Dixon & Candace Cumberbatch, Bond Price Hit New Highs, Lifted by Concerns About Japan and Signals of a U.S. Slowdown, Wall St. J., July 7, 1998, at C19. An individual facing a 28 percent Federal marginal tax rate would have an after-tax return of 4.0 percent. Subtracting the change in the consumer price index for the twelve-month period ending in May 1998, which is 1.7 percent, see U.S. Bureau of Labor Statistics, Consumer Price Index Summary (visited July 8, 1998) <http://stats.bls.gov/news.release/cpi.nws.html>, would result in a discount rate of 2.3 percent.

193. See Arnold, supra note 22, at 181.

194. See id. at 184–85.

195. See id. at 190.

196. See supra text accompanying notes 183–184.

197. In the case of environmental regulation, the government is not making the investment, but is instead requiring private parties to make it. The same analysis is applicable, however. See Arnold, supra note 22, at 189–91.

198. See id. at 180–84; Lind, supra note 22, at S–10, S–11.

The Department of Energy continues to engage in this inquiry:

Because the proposed appliance efficiency standards will primarily affect private, rather than public, investment, the Department continues to believe that using the average real rate of return on private investment as the basis for the social discount rate is most appropriate. If the primary impact of the standards were on Federal or other public expenditures, DOE agrees that real interest rates on long term government securities would likely be a better basis.

60 Fed. Reg. 37,388, 37,394 (1995).

199. See Arnold, supra note 22, at 184–85; Lind, supra note 22, at S–8, S–9.

200. See Arnold, supra note 22, at 184–85, 190–91; Lind, supra note 22, at S–8, S–9.

201. See Ronald G. Cummings, Legal and Administrative Uses of Economic Paradigms: A Critique, 31 Nat. Resources J. 463, 471 (1991); Randolph M. Lyon, Federal Discount Rate Policy, The Shadow Price of Capital, and Challenges for Reforms, 18 J. Envtl. Econ. & Mgmt. S–29, S–30 (1990). For an interesting survey of the different choices of discount rates in Federal agencies, see Edward R. Morrison, Comment, Judicial Review of Discount Rates Used in Regulatory Cost-Benefit Analysis, 65 U. Chi. L. Rev. 1333, 1336–37, 1364–69 (1998).

202. 59 Fed. Reg. 45,872, 45,895–97 (1994).

203. See 43 C.F.R. 11.84(e)(2) (1998) (Department of the Interior). Ohio v. Department of the Interior, 880 F.2d 432, 464–65 (D.C. Cir. 1989), upheld the Department of the Interior's choice of a 10 percent discount rate for natural resources damages, following OMB's pre-1992 policy, see supra text accompanying note 182.

204. See supra text accompanying notes 73–75.

205. See supra text accompanying notes 133–143.

206. See supra text accompanying notes 153–160.

207. See supra text accompanying note 156.

208. See Jones-Lee et al., supra note 159, at 55–57.

209. In contrast, in the Cropper and Subramanian study, the respondents were asked to evaluate the ease with which each of the risks could be avoided. See supra text accompanying notes 136–138.

210. The upward adjustment resulting from the unrepresentativeness of the risk preferences of the population exposed to workplace risks cannot be estimated as a result of the paucity of

the empirical data, though logic compels the conclusion that such workers will have a lower-than-average willingness-to-pay to avoid risk. See supra Part I.E.2.b.

211. See supra text accompanying notes 123–125.

212. See supra text accompanying notes 103–106.

213. For a 20 year lag, a discount rate of 2 percent reduces the valuation to 67 percent of the undiscounted amount, as compared to a reduction to 55 percent of the undiscounted amount for a 3 percent discount rate.

214. See supra text accompanying notes 183–184.

215. See supra text accompanying notes 80–83.

216. The OMB approach, however, avoids the pitfall of using V[in'60,60'] as the basis for estimating V[in'40,40']. Such a procedure might lead to undervaluation because of changes over time in the income and saving levels of individuals. See supra Part I.E.1.b.

217. The adjustments for the dread nature of the harm, the involuntary nature of the harm, the salary differential, and the impact of economic growth are 2, 2, 1.23, and 1.22, respectively. See supra text accompanying notes 204–213. The calculation assumes that all the factors are multiplicative. See supra text accompanying notes 206–210. This assumption should be the focus of empirical study.

218. See B.T. Westerfield, Asbestos-Related Lung Disease, 85 Southern Med. J. 616 (1992). Some of the adverse consequences of exposure to asbestos have latency periods of 30 and 40 years. See id. at 618.

219. See supra Part I.E.2.b.

220. See supra text accompanying notes 177–179.

221. For discussion of the differences with the intergenerational setting, see infra text accompanying notes 281–283.

222. See supra text accompanying notes 65–69.

223. See supra text accompanying note 35 (discussing Barnes's testimony).

224. See supra Part I.F.1.

225. See supra Part I.G.

226. See supra text accompanying notes 214–218.

227. For applications of this concept in the legal literature, see Bruce Ackerman & Anne Alstott, The Stakeholder Society (forthcoming 1999) (manuscript at 131–42, on file with the Columbia Law Review); Christine Jolls, Contracts as Bilateral Commitments: A New Perspective on Contract Modification, 26 J. Legal Stud. 203, 210, 219–24 (1997); Christine Jolls et al., A Behavioral Approach to Law and Economics, 50 Stan. L. Rev. 1471, 1538–41 (1998); Deborah M. Weiss, Paternalistic Pension Policy: Psychological Evidence and Economic Theory, 58 U. Chi. L. Rev. 1275, 1285–86, 1300–06 (1991).

228. Intergenerationally, the situation is different because the individual making the decision is different from the individual affected by the decision. See infra text accompanying notes 281–283.

229. Ackerman & Alstott, supra note 227, at 141.

230. See supra note 192.

231. For critiques of cost-benefit analysis, see Steven Kelman, Cost-Benefit Analysis: An Ethical Critique, Regulation, Jan./Feb. 1981, at 33; Duncan Kennedy, Cost-Benefit Analysis of Entitlement Problems: A Critique, 33 Stan. L. Rev. 387 (1981). For critiques of the techniques for valuing human lives, see sources cited supra note 64.

232. See supra text accompanying notes 21–22.

233. See William D. Nordhaus, Managing the Global Commons: The Economics of Climate Change 4 (1994) ("A complete analysis of the economics of climate change must recognize the extraordinarily long time lags involved in the reaction of the climate and economy to greenhouse gas emissions.").

234. For a comprehensive list, see 1 Philippe Sands, Principles of International Environmental Law 198–213 (1995).

235. Stockholm Declaration of the United Nations Conference on the Human Environment, June 16, 1972, 11 I.L.M. 1461.

236. United Nations Conference on Environment and Development: Rio Declaration on Environment and Development, June 13, 1992, 31 I.L.M. 874.

237. United Nations Conference on Environment and Development: Framework Convention on Climate Change, May 9, 1992, 31 I.L.M. 849.

238. Putnam & Graham, supra note 6, at 60.

239. Keeler & Cretin, supra note 5, at 303; see also id. at 304 ("Delaying any program . . . increases its benefit to cost ratio.").

240. See Arnold, supra note 22, at 178.

241. See Nordhaus, supra note 233, at 125 ("If investments in equipment or human capital yield 10 percent annually, it would be inefficient to make investments that yielded only 3 percent."); id. at 135.

242. See id. at 125.

243. See Hillman & Kim, supra note 5, at 200–02; Michael W. Jones-Lee & Graham Loomes, Discounting and Safety, 47 Oxford Econ. Papers 501, 511 (1995); Lipscomb, supra note 94, at S237.

244. See Lewis A. Kornhauser & Richard L. Revesz, Evaluating the Effects of Alternative Superfund Liability Rules, in Analyzing Superfund, supra note 133, at 115, 118.

245. See id.

246. In some cases, in contrast, environmental remediation costs may fall over time as a result of technological innovation.

247. Even if the cost were less than $100, a static evaluation would counsel against investing in remediation if the funds could be invested in an alternative project with a sufficient return.

248. In practice, the problem is more complicated because the increase in costs and damages is likely to be continuous but the structure of the analysis remains the same.

249. See William D. Nordhaus, Economic Approaches to Greenhouse Warming, in Global Warming: Economic Policy Responses 33, 58 (Rudiger Dornbusch & James M. Poterba eds., 1991) ("we are likely to be increasingly averse to climate change as the change becomes larger").

250. See Robert C. Lind, Intergenerational Equity, Discounting, and the Role of Cost-Benefit Analysis in Evaluating Global Climate Policy, 23 Energy Pol'y 379, 382 (1995); David W. Pearce et al., The Social Costs of Climate Change: Greenhouse Damage and the Benefits of Control, in Climate Change 1995: Economic and Social Dimensions of Climate Change 179, 184–86 (James P. Bruce et al. eds., 1996) [hereinafter Climate Change 1995].

251. See Pearce et al., supra note 250, at 214.

252. See Lind, supra note 250, at 384.

253. See James K. Hammitt, Outcome and Value Uncertainties in Global-Change Policy, 30 Climatic Change 125, 130 (1995).

254. See K. J. Arrow et al., Intertemporal Equity, Discounting, and Economic Efficiency, in Climate Change 1995, supra note 250, at 125, 132 ("society cannot set aside investments over the next three centuries, earmarking the proceeds for the eventual compensation of those adversely affected by global warming"); Farber & Hemmersbaugh, supra note 19, at 297 (same); Lind, supra note 250, at 381–82 (questioning society's ability to make transfers across several generations).

255. See Nordhaus, supra note 249, at 57.

256. Tyler Cowen & Derek Parfit, Against the Social Discount Rate, in Justice Between Age Groups and Generations 144, 148 (Peter Laslett & James S. Fishkin eds., 1992); see Farber & Hemmersbaugh, supra note 19, at 291; James C. Wood, Intergenerational Equity and Climate Change, 8 Geo. Int'l Envtl. L. Rev. 293, 321 (1996).

257. David W. Pearce & R. Kerry Turner, Economics of Natural Resources and the Environment 223–24 (1990); see Morrall, supra note 132, at 28 (without discounting "all rules yielding continuous benefits are worth any amount of immediate costs").

258. For further discussion, see infra Part II.C.

259. For example, Tyler Cowen and Derek Parfit note:

No generation can be morally required to make more than certain kinds of sacrifice for the sake of future generations. And this is part of a more general view, which has nothing to do with time. On this view, no one is required to make great sacrifices merely to benefit others.

Cowen & Parfit, supra note 256, at 149.

260. See Robert Solow, An Almost Practical Step Toward Sustainability, 19 Resources Pol'y 162, 168 (1993).

261. Maureen L. Cropper et al., Rates of Preference for Saving Lives, 80 Am. Econ. Rev. Papers & Proc. 469, 469 (1992) [hereinafter Cropper et al., Rates of Time Preference]. For an earlier version of the study, see Maureen L. Cropper et al., Discounting Human Lives, 3 Am. J. Agric. Econ. 1410 (1991).

262. See Cropper et al., Rates of Time Preference, supra note 261, at 469.

263. See id. at 471 tbl.1. For studies using shorter timeframes, see Cairns, supra note 164, at 222; John A. Cairns & Marjon M. van der Pol, Saving Future Lives: A Comparison of Three Discounting Models, 6 Health Econ. 341, 343 (1997); Horowitz & Carson, supra note 11, at 408; Jan Abel Olsen, Time Preferences for Health Gains: An Empirical Investigation, 2 Health Econ. 257, 259 (1993).

264. See Johannesson & Johansson, supra note 13, at 331. For an evaluation of the extent to which the framing of the question affects the results, see Magnus Johannesson & Per-Olov Johansson, Saving Lives in the Present Versus Saving Lives in the Future—Is There a Framing Effect, 15 J. Risk & Uncertainty 167, 169 (1997) [hereinafter Johannesson & Johansson, Risk & Uncertainty].

265. See Cropper & Portney, supra note 73, at 375. The study is Ola Svenson & Gunnar Karlsson, Decision-Making, Time Horizons, and Risk in the Very Long-Term Perspective, 9 Risk Analysis 385 (1989).

266. See supra text accompanying notes 92–97. As three prominent commentators recently explained:

If one discounts present world GNP over 200 years at 5 percent per annum, it is worth only a few hundred thousand dollars, the price of a good apartment. On the basis of such valuations, it is clearly irrational to be concerned about global warming, nuclear waste, species extinction, and other long-term phenomena. Yet we are worried about these issues, and are actively considering devoting very substantial resources to them. There appears to be a part of our concern about the future that is not captured by discounted utilitarianism.

Andrea Beltratti et al., Sustainable Growth and the Green Golden Rule, in The Economics of Sustainable Development 147, 149 (Ian Goldin & L. Alan Winters eds., 1995).

267. See Cairns, supra note 164, at 224–25 ("the further in the future the benefit the lower the rate at which most individuals discount it"); Cairns & van der Pol, supra note 263, at 342 (referring to "increasing evidence . . . that individuals do not appear to apply a constant discounting model"); Cropper et al., Rates of Time Preference, supra note 261, at 471 ("Discount rates are much higher for short horizons than for long horizons."); Johannesson & Johansson, Risk & Uncertainty, supra note 264, at 174 ("estimated discount rates decrease[] with the time horizon"); Olsen, supra note 263, at 262 ("The longer the time horizon, the lower are the implied [discount] rates."). One study found a similar result in an intragenerational context. See Loewenstein & Thaler, supra note 176, at 184 ("discount rates declined sharply with the length of time to be waited").

268. See supra text accompanying notes 264–265 (discussing Svenson & Karlsson study).

In arguing in favor of a constant discounting model, William Nordhaus states that "it would be unrealistic to make decisions based on the premise that there is, in fact, no time preference given that many social decisions are, in fact, tilted in favor of present generations." Nordhaus, supra note 233, at 123. It is therefore worth emphasizing that the studies discussed in this section reveal a strong moral intuition against such discounting.

269. See Arrow et al., supra note 254, at 137–38; Cropper & Sussman, supra note 65, at 162; Fuchs & Zeckhauser, supra note 161, at 265; Jones-Lee & Loomes, supra note 243, at 501; Lind, supra note 250, at 385–86.

270. See Arrow et al., supra note 254, at 130, 134.

271. In theory, the rate could also be negative, which would imply the privileging of the utilities of later generations.

272. See Arrow et al., supra note 254, at 134–35; Lind, supra note 250, at 385. If one adds utilities over an infinite time period, the social welfare function will be ill-defined; to avoid this problem, some discounting would be required. See Arrow et al., supra note 254, at 136; Jones-Lee & Loomes, supra note 243, at 507, n.10. As Kenneth Arrow and his coauthors explain, however, "because even a very small positive discount rate . . . would resolve the mathematical issue, this objection has little practical moment." Arrow et al., supra note 254, at 136.

273. Arrow et al., supra note 254, at 130; see Nordhaus, supra note 233, at 123–24; David Pearce et al., Sustainable Development: Economics and Environment in the Third World 30 (1990). For the derivation of the relationship, see Arrow et al., supra note 254, at 134–35.

274. See Arrow et al., supra note 254, at 130; Lind, supra note 250, at 384.

275. See Cline, supra note 106, at 249; Arrow et al., supra note 254, at 134.

276. Fuchs & Zeckhauser, supra note 161, at 265 (emphasis added).

277. See supra text accompanying notes 21–22.

278. See Robert C. Lind, Intertemporal Equity, Discounting, and Economic Efficiency in Water Policy Evaluation, 37 Climatic Change 41, 52 (1997).

279. See Thomas C. Schelling, Intergenerational Discounting, 23 Energy Pol'y 395, 396 (1995) ("To be less interested in the welfare of East Africans than former Yugoslavians is less like 'discounting' than, perhaps, 'depreciating.' When we count future welfare less than our own we are depreciating generations that are distant in time, in familiarity, in culture, in kinship, and along other dimensions.").

280. As a result, the issue of growth discounting is not presented by the example.

281. Of course, taking a "multiple selves" analysis to its logical conclusions, see supra text accompanying notes 227–230, would turn any intragenerational problem into an intergenerational problem.

282. See Cowen & Parfit, supra note 256, at 155 ("Pure time preference within a single life does not imply pure time preference across different lives."). As Joseph Lipscomb notes in the medical context, with respect to future generations, "discounting represents a global political decision about the relative weights current decisionmakers should attach to future population cohorts." Lipscomb, supra note 94, at S246. He adds that this discount rate "need have no relationship to how a given population member (or a statistically representative member) values current versus future gains in health status." Id.

283. See supra text accompanying notes 227–230 (discussing "multiple selves").

284. See Richard Dubourg & David Pearce, Paradigms for Environmental Choice: Sustainability versus Optimality, in Models of Sustainable Development 21, 24 (Sylvie Faucheux et al. eds., 1996) ("For maximizing a single utility function . . . over infinite time cannot help but suggest that we are dealing with a single generation which exists forever, or even a single individual."); Lind, supra note 250, at 385 (discussing why other approaches are preferable). For example, Kenneth Arrow and his co-authors acknowledge that the rate of time preference "is sometimes said to represent discounting for impatience or myopia." Arrow et al., supra note 254, at 131. These are precisely the sorts of psychological characteristics that justify intragenerational discounting.

285. The problem is fairly pervasive. For example, Kenneth Arrow and his co-authors note that discounting for time preference reflects that "one cares less about tomorrow's consumer than today's, or about one's own welfare tomorrow than today." Arrow et al., supra note 254, at 130. This formulation conflates the intergenerational and intragenerational problems.

286. See Lipscomb, supra note 94, at 238 (constant discounting "is basically a political judgment about intergenerational equity").

287. Arrow et al., supra note 254, at 131; Parfit, supra note 21, at 485.

288. An even narrower view of the role of future generations in the utilitarian calculus is that of Maureen Cropper and Frances Sussman. They explain their approach:

Each generation receives utility from its own consumption and that of its immediate descendants. Because this is true of all generations, the current generation necessarily takes into account the utilities of all future generations in making its consumption and bequest plans.

Cropper & Sussman, supra note 65, at 170.

This approach has been criticized as unduly privileging the position of the current generation. See Zeckhauser, supra note 102, at 440–41 ("There is the significant issue . . . whether . . . this sort of altruism does not substantially underrepresent the impacts that will be truly felt.").

289. See supra text accompanying notes 261–268.

290. See Arrow et al., supra note 254, at 137.

291. See supra text accompanying notes 21–22; Schelling, supra note 279, at 396.

292. See Arrow et al., supra note 254, at 136; Jones-Lee & Loomes, supra note 243, at 502 n.4; George Tolley & Robert Fabian, Future Directions for Health Value Research, in Tolley et al., supra note 70, at 300, 311.

293. See Arrow et al., supra note 254, at 136 ("Some have argued that the discount rate should be adjusted for the probability of extinction. Plausible estimates of this effect would add very little to the discount rate.").

294. See supra text accompanying notes 252–253.

295. See Parfit, supra note 21, at 482; Jones-Lee & Loomes, supra note 243, at 502 n.4; John F. Morrall III, Cotton Dust: An Economist's View, in The Scientific Basis of Health and Safety Regulation 93, 107–08 (Robert W. Crandall & Lester B. Lave eds., 1981).

296. See supra text accompanying notes 252–253.

297. See Heinzerling, supra note 7, at 2044–45.

298. It is conceivable that in some instance one could make a particularized, factually grounded case for a probabilistic reduction of harms.

299. John Rawls makes the following case against a pure time preference:

There is no reason for the parties [in the original position] to give any weight to mere position in time. They have to choose a rate of saving for each level of civilization. If they make a distinction between earlier and more remote periods because, say, future states of affairs seem less important now, the present state of affairs will seem less important in the future. Although any decision has to be made now, there is no ground for their using today's discount of the future rather than the future's discount of today. The situation is symmetrical and one choice is as arbitrary as the other. Since the persons in the original position take up the standpoint of each period, being subject to the veil of ignorance, this symmetry is clear to them and they will not consent to a principle that weighs nearer periods more or less heavily.

John Rawls, A Theory of Justice 294 (1971); see also id. at 284–98 (setting forth a theory of intergenerational justice). For commentary, see John Broome, Counting the Cost of Global Warming 31, 96–98 (1992); B.M. Barry, Justice Between Generations, in Law, Morality, and Society: Essays in Honour of H.L.A. Hart 268, 276–81 (P.M.S. Hacker & J. Raz eds., 1977).

300. See supra Part I.H.

301. Some prominent economists are at the very least ambivalent about discounting for pure time preference. For example, Robert Solow notes:

You may wonder why I allow discounting at all. I wonder, too: no generation 'should' be favored over any other. The usual scholarly excuse—which relies on the idea that there is a very small fixed probability that civilization will end during any little interval of time—sounds far-fetched. We can think of intergenerational discounting as a concession to human weakness or as a technical assumption of convenience (which it is).

Solow, supra note 260, at 165; see also Cline, supra note 106, at 249 ("Impatience or 'myopia' may be a legitimate basis for a single individual's preferring consumption earlier rather than later in his lifetime, but from society's standpoint it is hardly a justifiable basis for making intergenerational comparisons"); Lind, supra note 22, at S–20 (intergenerational discounting "would seem a highly questionable if not immoral public policy"); Robert M. Solow, Intergenerational Equity and Exhaustible Resources, 41 Rev. Econ. Stud. 29, 40 (1973) (expressing doubts as to whether time discounting is appropriate). Kenneth Arrow and his co-authors do not analyze explicitly what the rate of time preference should be, but assume at times that it would be zero. See Arrow et al., supra note 254, at 131.

302. In practice, the distinction is not as crisp because generations are not successive, but overlapping. The conceptual distinction, however, remains important. For models of overlapping generations, see Burton, supra note 13; Cropper & Sussman, supra note 65, at 169–72. When generations overlap, the current generation tends to convey benefits on the next generation even when it is motivated only by its self-interest. See Barry, supra note 299, at 268 (as a result of the overlap "prudent provision for the welfare of all those currently alive therefore entails some considerable regard for the future").

303. See Geoffrey H. Heal, Discounting and Climate Change: An Editorial Comment, 37 Climate Change 335, 335 (1997).

304. See supra text accompanying notes 273–275.

305. See Arrow et al., supra note 254, at 134–35.

306. See id. at 131–32, 141 n.10.

307. See id. at 132.

308. See supra Part I.E.1.a.

309. See Cline, supra note 106, at 116–19; Pearce et al., supra note 250, at 195, 198.

310. See supra text accompanying note 100.

311. See Heinzerling, supra note 7, at 2051.

312. See Cline, supra note 106, at 101–06 (discussing species loss and damage to forests).

313. See Arnold, supra note 22, at 177; Heinzerling, supra note 7, at 2051.

314. See Cline, supra note 106, at 110–12.

315. See Schelling, supra note 279, at 399.

The 1990 Amendments to the Montreal Protocol on Substances that Deplete the Ozone Layer marked the first time that a developing country's adherence to the provisions of an international environmental treaty was linked to the receipt of financial resources. See 1 Sands, supra note 234, at 269. As Philippe Sands points out, these amendments "introduced a radical and innovative change which has had profound consequences on the negotiation of subsequent global environmental treaties." Id. This change is evident in the provisions of the 1992 Climate Change Convention which requires developed countries to provide financial assistance and technological assistance to developing countries. See id. at 740–41.

316. See World Bank, GNP Per Capita (visited July 24, 1998) <http://www.worldbank.org/depweb/gnp/gnpaas01.htm>.

317. The differences in the patterns of per capita energy consumption between developed and developing countries are stark. See International Energy Agency, Climate Change Policy Initiatives 28 tbl.3 (1992). Over time, this share of the responsibility might decrease as developing countries industrialize.

318. Perhaps, however, there is a concern that direct foreign aid would not be spent wisely by the recipient, or could create undesirable incentives. If these problems were sufficiently serious, long-term environmental investments could be the most desirable way of providing foreign assistance.

319. See Louis Kaplow, The Optimal Supply of Public Goods and the Distortionary Cost of Taxation, 49 Nat'l Tax J. 513, 516–19 (1996); Louis Kaplow & Steven Shavell, Property Rules Versus Liability Rules: An Economic Analysis, 109 Harv. L. Rev. 713, 744–45 (1996). For discussion of the distributional consequences of environmental policy, see Richard L. Revesz, Foundations of Environmental Law and Policy 102–03 (1997).

320. See Farber & Hemmersbaugh, supra note 19, at 300.

321. The substitutability of these future benefits is discussed below in the context of the principle of sustainable development. See infra Part II.E.

322. See infra text accompanying notes 343–344.

323. See supra text accompanying notes 254–256.

324. See, e.g., Gary D. Meyers & Simone C. Muller, The Ethical Implications, Political Ramifications and Practical Limitations of Adopting Sustainable Development as National and International Policy, 4 Buff. Envtl. L.J. 1, 10 (1996) ("The core idea of sustainability, then, is the concept that current decisions should not impair the prospects for maintaining or improving future living standards."); Edith Brown Weiss, Intergenerational Equity: A Legal Framework for Global Environmental Change, in Environmental Change and International Law: New Challenges and Dimensions 385, 385 (Edith Brown Weiss ed., 1991) ("Sustainable development rests on a commitment to equity with future generations.").

For a strong critique of the concept of sustainable development, see Wilfred Beckerman, Through Green-Colored Glasses: Environmentalism Reconsidered 143–60 (1996).

325. See Dubourg & Pearce, supra note 284, at 27 ("Sustainability has become a common policy objective of many government institutions, international agencies, and non-governmental organisations."); supra text accompanying notes 234–237.

326. Some commentators link the attractiveness of sustainable development with criticisms of discounting approaches: "There appears to be a part of our concern about the future that is not captured by discounted utilitarianism. Perhaps as much as anything it is this that is driving an interest in formalising the concept of sustainability." Beltratti et al., supra note 266, at 149.

327. See David Hodas, The Climate Change Convention and Evolving Legal Models of Sustainable Development, 13 Pace Envtl. L. Rev. 75, 77 (1995); Averil Rothrock, Oregon's Goal Five: Is Ecologically Sustainable Development Reflected?, 31 Willamette L. Rev. 449, 451 (1995); Mary Pat Williams Silveira, International Legal Instruments and Sustainable Development: Principles, Requirements, and Restructuring, 31 Willamette L. Rev. 239, 243 (1995); Christopher D. Stone, Deciphering "Sustainable Development", 69 Chi.-Kent L. Rev. 977, 978 (1994). For general discussion of the principle of sustainable development, see 1 Sands, supra note 234, at 198–208.

One commentator has suggested that over 70 definitions of the term exist. See Susan L. Smith, Ecologically Sustainable Development: Integrating Economics, Ecology, and Law, 31 Willamette L. Rev. 261, 276 (1995); see also John Peezey, World Bank Environment Paper Number 2: Sustainable Development Concepts: An Economic Analysis, app. A (1992) (presenting an extensive list of definitions).

328. World Commission on Environment and Development, Our Common Future (1987).

329. Id. at 43.

330. See Weiss, supra note 324, at 401–05; Solow, supra note 260, at 162.

331. The following two paragraphs are adapted from Revesz, supra note 319, at 307–08.

332. See Weiss, supra note 324, at 401–05; Edith Brown Weiss, In Fairness to Future Generations: International Law, Common Patrimony, and Intergenerational Equity 40–45 (1988).

333. See Solow, supra note 260, at 162–63.

334. See id. at 167–68.

335. See id. at 168.

336. Compare Weiss, supra note 324, at 404 ("The principle of conservation of quality requires that we leave the quality of the natural and cultural environments in no worse condition than we received it."), with Solow, supra note 260, at 167 ("If sustainability means anything more than a vague emotional commitment, it must require that something be conserved for the very long run.").

337. Compare Weiss, supra note 324, at 404 ("We may exhaust more reserves of a natural resource and cause modest levels of pollution, but pass on a higher level of income, capital, and knowledge sufficient to enable future generations to develop substitutes for the depleted resource and methods for abating or removing pollutants."), with Solow, supra note 260, at 168 ("Most routine natural resources are desirable for what they do, not for what they are. It is their capacity to provide usable goods and services that we value. Once that principle is accepted, we are in the everyday world of substitutions and tradeoffs.").

338. Compare Weiss, supra note 324, at 403 (we "must proceed extremely cautiously" with respect to the possible destruction of a "unique natural resource"), with Solow, supra note 260, at 168 ("It makes perfectly good sense to insist that certain unique and irreplaceable assets should be preserved for their own sake").

339. See Solow, supra note 260, at 163 ("So far . . . the proper adjustments needed to measure the stocks and flows of our natural resources and environmental assets are not being made in the published national accounts.").

340. See Michael Jacobs, The Green Economy: Environment, Sustainable Development and the Politics of the Future 84 (1991) ("The final objection which might be made to our definition of sustainability is that it ignores population growth."); Michael Redclift, Sustainable Development: Exploring the Contradictions 29 (1987) ("The concept of 'sustainability' makes little sense . . . unless we also consider the impact of rapid population growth on the physical resource base."); Nafis Sadik, Population, Environment, and Sustainable Development, in In the Aftermath of the Earth Summit 21, 23 (Andreas Gettkant ed., 1993) ("The universal acceptance of the strong links between sustainable development and the preservation of the environment does not extend to the links between these two and the population policy."). But see President's Council on Sustainable Development, Population and Consumption Task Force Report 13–32 (1997) (discussing how population growth is linked to sustainability).

The link to population does not play a role in the discussions by Weiss, supra note 324, at 401–05, and Solow, supra note 260.

341. For an exploration of the ethical consequences of this link, see Parfit, supra note 21, at 351–441; Broome, supra note 86, at 161–62.

342. See Jacobs, supra note 340, at 84 ("It could be argued that what sustainability demands is not simply a constant level of environmental capacity but a constant per capita or per person level."); Richard Baldwin, Does Sustainability Require Growth?, in The Economics of Sustainable Development, supra note 266, at 51, 52 ("The simple fact is that current population growth rates, if they were maintained, would lead to an unsustainable world population.").

343. See Gregory D. Fullem, The Precautionary Principle: Environmental Protection in the Face of Scientific Uncertainty, 31 Willamette L. Rev. 495, 500–01 (1995); Alexandre Kiss, The Rights and Interests of Future Generations and the Precautionary Principle, in The Precautionary Principle and International Law: The Challenge of Implementation 19, 27 (David Freestone & Ellen Hey eds., 1996); Bernard A. Weintraub, Science, International Environmental Regulation, and the Precautionary Principle: Setting Standards and Defining Terms, 1 N.Y.U. Envtl. L.J. 173, 177–78 (1992). For a discussion of the status of the precautionary principle in international environmental law, see 1 Sands, supra note 234, at 208–13.

344. See supra text accompanying notes 252–253.

345. These issues are explored briefly in Revesz, supra note 319, at 330–31.

346. In this context, the principle of sustainable development has the same features as the maximin principle.

347. See supra text accompanying notes 314–316.

348. See supra text accompanying notes 281–286.

349. Other objections to growth discounting are discussed at supra text accompanying notes 308–311.

350. See supra Part II.E.

351. See supra text accompanying notes 319–320.

352. See supra text accompanying notes 316–317.

353. See supra text accompanying note 317.

STATEMENT OF BERNARD MELEWSKI, ADIRONDACK COUNCIL

Good Morning. My name is Bernard C. Melewski. I am counsel and legislative director of the Adirondack Council. I would like to thank the chairman, and the members of the committee for the opportunity to be here with you this morning and to provide testimony regarding the reauthorization of the Clean Air Act.

I would like to begin with a brief explanation of the Adirondack Park, the role of the Adirondack Council in New York, and why we are particularly interested in the topic of acid rain and in the Clean Air Act.

The Adirondack Park is the largest park of any kind in the contiguous United States. It is nearly three times the size of Yellowstone National Park and covers one fifth of the State of New York making it equal in size to the State of Vermont. The Adirondack Park is roughly six-million acres of public and private land containing the largest assemblage of Old Growth forest east of the Mississippi River. The Adirondacks include the headwaters of five major drainage basins. Lake Champlain and the Hudson, St. Lawrence, Mohawk and Black rivers all draw water from the Adirondack Park. Within the Park are more than 2,800 lakes and ponds, and more than 1,500 miles of rivers fed by an estimated 30,000 miles of brooks and streams. The Park contains 46 mountain peaks more than 4,000 feet tall. Forty-five percent of the Park is publicly owned Forest Preserve protected as "Forever Wild" by the New York State Constitution since 1895. One million acres of these public lands are classified as Wilderness.

The Adirondack Council was founded in 1975; it is a private, not-for-profit organization dedicated to enhancing the natural and human communities of the Park through research, education, advocacy and legal action. Our main offices are located within the Adirondack Park, with a satellite office in Albany, New York, the State capitol.

The Council receives moral and financial support from its more than 18,000 members and from private foundations. The Council's national and regional member organizations include the Natural Resources Defense Council, The Wilderness Society, National Audubon Society, National Parks and Conservation Association, Citizens Campaign for the Environment and the Association for the Protection of the Adirondacks.

Our interest in The Clean Air Act and the problem of acid rain is long held. We were active contributors to the dialogue on acid rain in New York State in the early years of the 1980s, and helped craft the first acid rain law in the country which was adopted in 1984. The New York law identified both sulfur dioxide and nitrogen oxide as precursors to acid rain, sought limits on total emissions from utilities sited within the State and even proposed an innovative trading mechanism that Congress would adopt nationwide in the Clean Air Act Amendments of 1990.

The Adirondack Council was also an active participant in the national debate that led to the adoption of the acid rain program in Title IV of the Clean Air Act Amendments 8 years ago. Our publication, "Beside the Stilled Waters," which was pro-

duced and distributed in cooperation with our member organizations, brought the problem of acid rain to the attention of the nation and to Congress.

The enactment of Title IV of the Clean Air Act Amendments of 1990, known as the Acid Rain Program, were not without controversy. Congress adopted an innovative "cap and trade" program, modeled after the New York legislation, which would abandon the so-called "command and control" approach to regulation, in favor of a free wheeling pollution allowance trading program that would provide utilities with the flexibility to make compliance strategies part of their long-term business planning. Both the need for and the cost of the program were hotly debated.

The Adirondack Council was among the critics. We raised concern that the cap on total emissions might not be low enough to protect sensitive areas. We used our membership on EPA's advisory committee to seek changes as the agency developed regulations to implement Title Four. Among other issues, the Adirondack Council felt that too many credits were in the system and that EPA was not pushing to require the most modern monitoring systems. Together with the Natural Resources Defense Council, we reluctantly sought changes in Federal court. (Environmental Defense Fund, et al. V. Browner, No. 93-1203 and Consolidated Cases).

I am pleased to say that years of good-faith negotiation with the USEPA and the affected industry resulted in very positive changes to the program. The Adirondack Council formally withdrew our legal challenge to the regulatory program just a few weeks ago.

Over the past year, the program of Title Four has been hailed as a new beginning in cost-effective air regulation that puts the market to work to the benefit of the health and welfare of millions of Americans. Emission trading has been heralded as the solution to pollution reduction within the United States and indeed the globe.

We are here to say that before we run to embrace trading in other pollutants and in other markets, we need to take a hard look at the results of the great sulfur experiment.

We remember well that day when a deputy administrator for the Environmental Protection Agency grandly pronounced in a press release that the regulations implementing the new Clean Air Act Amendments would mean "the end to acid rain in the Adirondacks."

Certainly that was the intention of the Senate and the House. But wisely, Congress ordered in 1990 that a series of reports be prepared over the next few years, that would advise you of the projected results of the acid rain program.

The wisdom of requiring these reports at that time is now apparent. Until recently, we had some doubt that the members of the Senate would ever see them.

The first report was due in 1993, from the Environmental Protection Agency (ordered under sec. 404, Title IV appendix B of the 1990 CAAA) and was entitled the Acid Deposition Standard Feasibility Study Report to Congress. The report, dated October, 1995, was finally released in 1996, in partial settlement of the lawsuit brought by the Natural Resources Defense Council, the Adirondack Council and the State of New York.

The report concluded that the pollution reductions accompanying the 1990 Clean Air Act Amendments would not be sufficient to allow recovery of certain sensitive ecosystems (including the Adirondacks) and that many would continue to get worse. The report was particularly compelling for New Yorkers because it revealed that despite the reductions expected from the 1990 Amendments the loss of nearly 50 percent of its lakes and acidification of most streams in the Adirondack Park could be expected.

The second of two reports to Congress, the report of the National Acid Precipitation Assessment Program (NAPAP) was due in 1996, and was finally submitted to Congress as you left for the August recess in 1998 (ordered under Sec. 901J of the 1990 CAAA). It too was released under the threat of litigation from the State of New York. Despite its May 1998 title, the document would not be realistically available to the public until a year later (May, 1999), almost 9 months after its transmission to Congressional committees.

In short summary, the NAPAP report peer reviewed, confirmed and substantially elaborated upon the findings of the earlier report to Congress submitted by the EPA.

We believe that a fair reading of the two reports to Congress lead to two very clear conclusions:

First, that the mechanism of a national cap in emissions coupled with the pollution allowance trading program has been an outstanding success. All facilities are in compliance and there is every reason to believe that the target level of emissions will be reached. The administrative and implementation costs of the program are less than a traditional regulatory approach. The actual cost of the program is substantially less than projected at the time of adoption.

According to EPA's 1998 Compliance report for the Acid Rain Program, all 713 utility boilers and turbines affected by the SO_2 and NOx regulations met their emissions goals for 1998 as they have for every year since the program's inception. The simple, efficient design of the program, coupled with large automatic penalties for exceedences and the diligence of EPA administrators and the regulated community are all factors in this success. We can look forward to similar results when Phase II of the program, which will include many more power plants, begins.

The administrative and implementation costs are far below those associated with traditional regulatory approaches because in many ways the program is self-implementing. Devices known as Continuous Emissions Monitors (CEMS) count each ton of pollution as it is emitted from the smokestack. At the end of each year a utility must have enough credits (either initially allocated or purchased) to cover those emissions. The accounting of allowance holdings and trading is in a database maintained by EPA.

The compliance costs of the program are proving to be far below those estimated when Title IV was adopted. EPA estimated that the fully implemented program would cost four billion dollars a year; industry estimates were much higher. According to the Massachusetts Institute of Technology, compliance costs have so far been less than $1 billion per year. Again, the design of the program helped achieve these relatively low compliance costs. Other factors, such as rail transportation improvements that reduced the cost of transporting low-sulfur coal were crucial here as well. Projections (by EPA and ICF Resources) of what new SO_2 and NOx reductions would cost beyond those called for in Title Four indicate that deep new reductions could be achieved at or near the initial $4 billion estimate.

While we hold no special expertise in the field of the health effects of air pollution, a brief review of the literature reveals some interesting facts. EPA studies (Human Health Benefits from Sulfate Reductions Under Title IV of the Clean Air Act, 1995) indicate that every dollar spent on reducing sulfate emissions can result in tens of dollars in savings in health care costs. With asthma cases on the rise nationwide we need to be aware that even brief exposure to relatively low levels of sulfur dioxide has been repeatedly shown to trigger asthma attacks.

The market for trading allowances is improving as well. Each year there are more trades between utilities occurring and the value of each allowance is rising steadily. In fact, the Adirondack Council is a market participant.

Over the past 2 years, we have acquired thousands of pollution allowance credits, most of them donated as a community good will gesture by utilities in New York. Unlike most other holders of allowances, it is our intention to retire all credits we may obtain by transferring them to a retirement account we maintain with USEPA. The Adirondack Council has permanently retired one-ton of sulfur dioxide on behalf of thousands of individuals around the nation, including New York Governor George Pataki.

The Second major finding of the two reports is that despite the success of the regulatory scheme, the overall cap in emissions is too high to accomplish the primary goal, which was to protect sensitive resource areas from the harmful effects of acid rain. The national cap on emissions of sulfur-dioxide from power plants must be cut. The reports agree that nitrogen oxide emissions are a significant contributor to acid rain and must be addressed.

The NAPAP report also confirms that acid rain is not just an Adirondack problem.

The damage that sulfur and nitrogen pollution causes is far from a regional issue. It is an issue of national, even international importance. Excess nitrogen in waters and in soils—"nitrogen saturation"-can be found in the Northeast and in West Virginia's Allegheny Mountains, Tennessee's Great Smoky Mountains, Colorado's Front Range of the Rockies and even as far west as the San Bernardino and San Gabriel Mountains of California. High levels of nitrogen deposition are causing nitrate to leach into stream water from these watersheds. This nitrate leaching acidifies streams and strips base cations from soils. In snow covered areas the flush of nitric acid stored in the snowpack is the leading cause of "acid pulses" which are responsible for fish kills during spring thaws.

NAPAP found that high elevation areas in the Northeast and the Appalachians are bathed in acidic cloud water for extended periods of time. Sulfuric acid from sulfur dioxide emissions is the significant cause of the widespread loss of red spruce trees in these areas. The mechanism for the die back is the leaching of calcium from the spruce needles and aluminum from the soils by the acidic fog which makes the trees susceptible to frost and winter injury.

The coastal estuaries of the entire east coast suffer from airborne inputs of nitrogen that can make up nearly 40 percent of the total nitrogen loaded into their systems. In estuary systems such as the Long Island Sound, Narragansett Bay, the Chesapeake Bay and Tampa Bay in Florida, nitrogen-based pollution is overloading

the water with nutrients. This causes "eutrophication"—an overabundance of algae. When algae dies and decays, it depletes the water of precious oxygen needed by all aquatic animals. This condition is known as hypoxia. These blooms are associated with fin fish kills, shellfish kills and human illness.

NAPAP also concluded that areas of the United States that are not seeing damage now are likely to in the future due to an effect known as soil acidification. Over the long term, acidic deposition is slowly leaching away key soil nutrients like calcium and magnesium (known as base cations) that are essential for plant growth. This nutrient depletion is occurring in high and mid elevation forests in New England, New York and the Southern Appalachians. NAPAP cited studies concluded that 50 9 percent of the commercial pine forest soil in all of the southeast has low enough reserves of these chemicals to warrant concern.

Acid deposition, whether from sulfur or from nitrogen based pollution, not only leads to base depletion, but also the release of toxic compounds from soils to living things. For example, the release of aluminum from soils rapidly accelerates when pH drops below 5. The release of aluminum interferes with plant biochemistry. It is also the leading cause of fish mortality in affected lakes. In other words, it is not the acidity directly, but the aluminum toxicity that is responsible for the damage. This effect is very wide-spread. NAPAP cited studies conducted in the Shenendoah National Park show that fish species richness, population density, condition, age distribution, size and survival rate were all reduced in streams no longer able to neutralize acidity. Another NAPAP study of streams in the Adirondacks, Catskills and Northern Appalachians in Pennsylvania showed that episodic acidification "acid pulses" had long term adverse effects on fish populations including significant fish mortality.

Lake acidification, whether from sulfur or nitrogen is also implicated in the increase in mercury concentrations found in fish. Acidity leads to greater conversion of mercury from its less toxic elemental form to methyl mercury, which is much more toxic. Fish consumption warnings due to mercury contamination are common in many States and are on the rise. The bio-accumulation of mercury in some species of fish in New York has reached levels of grave concern to human health. In the western mountains of the Adirondack Park and in the Catskill Mountain reservoirs of New York City's water supply, the levels of mercury in fish exceed that which is safe for human consumption, and fishermen are urged to limit eating perch and bass. The acid rain problem is now a public health problem.

The cost to Americans from acid rain is not just the loss of pristine lakes in one of its greatest parks, or the almost imperceptible die out of sensitive species of trees, or even the haze that obscures the views of our national parks, it is also in the loss of our great monuments.

Acid rain is also falling on the District of Columbia. Acid rain is eating away at the marble of the Capitol building and that of many of the great monuments on the mall. The Lincoln memorial corrodes more every year. So it is with buildings and monuments throughout the Capitol, so numerous and so obvious that until recently you could obtain an illustrated walking tour guide to the acid rain damage to our nations capitol, thoughtfully provided free of charge. (Acid Rain and our Nation's Capital, US Dept. Of Interior / US Geological Survey. 1997)

The monuments to the fallen on the great battle sites of the Civil War, Gettysburg and Vicksburg, lose their inscriptions and carved features from the acid bath they endure each rainy day. The Statute of Liberty simply slowly melts away, day by day. This is why the fight to stop acid rain has been joined by many of the nation's prestigious organizations dedicated to historic preservation.

. The findings of the reports to Congress have been seconded by other studies that have found similar results; Environment Canada, in its 1997 report "Towards a National Acid Rain Strategy," said that reducing sulfur emissions significantly beyond the current Clean Air Act requirements in both countries would be needed for all of eastern Canada to be protected from acid rain. In southern Canada, an area the size of France and Britain combined continues to receive harmful levels of acid deposition. As many as 95,000 lakes in the region will remain damaged.

A study recently released by Trout Unlimited that was conducted by the University of Virginia found that without deep additional deposition reductions, up to 35 percent of Virginia trout streams would become "chronically acidic" and would no longer support trout populations. The study further estimated that thousands of trout stream miles in the Southern Appalachians may be lost to acidification.

Just a week ago the journal Nature, perhaps the most respected journal of its kind, published the broadest geographical study of acid rain to date. Written by 23 scientists, all of them top acid rain researchers, and taking samples from roughly 200 sites, the study again confirmed and elaborated on the disturbing findings of

earlier works. How much more does Congress need to hear before it takes additional action?

The disturbing and overwhelming evidence of the destruction of the streams, lakes and forests on public lands protected by our State constitution as forever wild, the contamination of fish in otherwise pure waters and the pollution of our coastal estuaries has raised grave concern in New York State. Our entire Congressional delegation co-sponsors legislation introduced by Senators Moynihan and Schumer (S.172), and in the House by Congressmen Boehlert and Sweeney (HR 25) that seeks further emission reductions.

In the past 2 years, the Office of the Attorney General of the State of New York has sought legal redress via other provisions of the Clean Air Act. Most recently, Attorney General Elliot Spitzer announced his intention in the coming weeks to bring suit against 17 utilities in five States to redress what he considers to be violations of the Clean Air Act that result in illegal emissions of acid rain precursors.

In our State legislature, bills have been repeatedly introduced and passed (A.889) by the Chairman of the Environmental Conservation Committee (Richard Brodsky, D, Scarsdale) that would discourage the trade or sale of pollution allowances by New York utilities to upwind sources of acid rain. In July of this year, the State Senate unanimously passed a similar bill (S.4917) sponsored by his Senate counterpart (Carl Marcellino, R, Oyster Bay).

The States that are most adversely affected by the damage from acid rain need to see clear movement by Congress to adjust the sulfur program and deal with the companion problem of the long-range transport of nitrogen oxides. The failure of the Senate and the House to act will result in more interstate litigation, and new efforts State-by-State to interfere with the free-market attributes that have led to the effectiveness of the program thus far. The better alternative is to fulfill the original intent of Congress to solve the acid rain problem by taking action soon.

We respectfully suggest that the Senate take prompt action to:

- Build on the successful sulfur dioxide cap-and-trade program by creating a third phase of reductions further along the current time line. All of the advantages of the current program can be preserved in a predictable, flexible, and cost-effective manner while reducing sulfur-dioxide emissions by an additional 50 percent.
- Create a new cap-and-trade program for nitrogen-oxide emissions from utility smokestacks that mirrors the successful program already in place for sulfur. This cap and trade program should reduce nitrogen emissions from utilities nationwide by approximately 70 percent of 1990 levels, resulting in a substantial and beneficial cut that is also reasonably achievable.

To put this recommendation in perspective, we would like to address the subject of the ongoing battle over new air regulations issued last September by the USEPA, which at this time is the subject of litigation.

USEPA has proposed a 22-State voluntary utility cap and trade program for nitrogen emissions as the preferred response for State compliance with its new ozone program.

The EPA ozone proposal, which is only summer seasonal, will not address in any significant way, the acid rain problem. The acid rain dilemma is the total loading of nitrogen to sensitive areas. For high elevation areas the main concern stems from the buildup of nitrogen in the snow pack and the subsequent "acidic pulse" to aquatic systems in the spring of the year. Year-round controls will be necessary to address the nitrogen problem. Furthermore, only nationwide reductions will address the problems outside of the twenty-two State region covered by EPA's plan.

Congress can level the competitive playing field for the utility industry by enacting national controls which will permit an expanded allowance trading market that will be more efficient and cost effective. The Congressional Budget Office has reached similar conclusions. In a report on the proposed nitrogen/ozone rules this summer. (Factors Affecting the Relative Success of EPA's NOx Cap-and-trade Program, June 1998), the CBO identified similar benefits that would result if Congress provided additional statutory authority to EPA.

Finally, we respectfully recommend:

- Congress should provide additional resources to the monitoring and research networks that, on a shoe-string budget, have provided the nation's research scientists with invaluable data on the actual state of affairs on the ground and in the air. The level of scientific certainty and confidence on acid rain has improved substantially since 1990, but existing research activities should be expanded.

The need for additional action on acid rain is not just a New York perspective. In May of 1998, the Conference of New England Governors and Eastern Canadian Premiers issued a joint call for action that recommended additional reductions in utility emissions of SO_2 and NOx. Earlier this year, the Adirondack Council was

privileged to be joined by national, State and regional organizations representing hundreds of thousands of Americans concerned about the health of our forests, the productivity of our coastal bays, the improvement of our fisheries and the protection of our heritage, in a public letter to Congress asking that the acid rain program be revisited.

Mr. Chairman, this nation committed itself to the task of ending the destruction of acid rain almost a decade ago. We think it is time to finish the job. Thank you again.

RESPONSES BY BERNARD MELEWSKI TO ADDITIONAL QUESTIONS FROM SENATOR BAUCUS

Question 1. The Clean Air Act has been highly successful, but there is still a lot of work to be done. Do you believe that there will be any effects on the nation's health and the environment if we do not go beyond the current clean air policies established in the 1990 Clean Air Act Amendments?

Response. Yes. There have been numerous government-produced analyses that project the trends in human and environmental health with full implementation of the 1990 CAAA used as a baseline that the Subcommittee has access to and has presumably examined. Most notable of these is the 1998 NAPAP Biennial Report to Congress, The 1995 USEPA Acid Deposition Standard Feasibility Study, and the exhaustive research conducted by USEPA during promulgation of its update of the National Ambient Air Quality Standards for ozone and particulates. Numerous studies by the States and academia have also examined what the likely impacts of failing to move beyond current clean air policies will be.

According to these sources we may look forward to the following brief and incomplete list of consequences: A doubling of the number of acidified lakes in the Adirondacks, a large increase in the proportion of episodically acidified streams throughout the Appalachians, a reduction in the growth rate and health of forests in the east from soil nutrient depletion, an increase in the number of water bodies with mercury contaminated fish, continuing agricultural crop loss and damage from ozone exposure, continuing eutrophication of coastal estuaries, continuing degradation of historic buildings and monuments.

We may experience acid rain related damage in parts of the country that were believed to be unaffected such as the Rocky Mountains and other western ranges, and areas currently affected may get worse due to long term exposure to acid deposition rates that are still too high for the environment to absorb.

In regards to human health effects, the existing record of the Committee from its hearings on USEPA's proposed NAAQS revisions for ozone and fine particulates amply demonstrates the disturbing effects we can expect if we do not "go beyond the current clean air policies" as your question inquires. It is noteworthy, however, that the NAAQS revisions that USEPA ultimately promulgated have been blocked in the courts for reasons including the ruling that USEPA overextended its congressionally delegated powers and that.Congress delegated too much power to USEPA in the first place. I find it curious that Congress had the opportunity to block the NAAQS revisions during its review of USEPA's promulgation process, but did not do so, yet now Congress allows the courts to block the NAAQS revisions through its own inaction.

Question 2. What are the primary mobile and stationary sources responsible for the impacts of acid rain and ozone pollution? What role does EPA's proposed sulfur standard for gasoline have in potential solutions?

Response. Acid rain and ozone pollution are caused by two precursor pollutants; sulfur dioxide and oxides of nitrogen. Sulfur dioxide plays no role in the formation of ozone but is an important source of acid rain and fine particulate pollution. There are many anthropogenic sources of sulfur dioxide, the principle one being fossil fuel powered electric generating plants, which account for over two-thirds of US emissions. The 1990 Clean Air Act Amendments have resulted in a significant reduction in sulfur dioxide emissions from these plants, but they remain the largest source category. If Congress decides to make deeper cuts in emissions of sulfur dioxide, as we believe they should, the logical source to seek reductions Tom is still electric generators.

The principal precursor for ozone, and a significant contributor to acid rain, are emissions of oxides of nitrogen, or NOx. About one-third of US anthropogenic NOx emissions come from the same electric generators that account for so much sulfur dioxide emissions. The other primary source of NOx, accounting for more than one-third of emissions, is the transportation sector. If Congress decides to make deeper

cuts in emissions of NOx, as we believe they should, both electric generation and transportation sources will need to be addressed.

EPA's proposed sulfur standard for gasoline is a necessary step in reducing NOx emissions from the transportation sector. Sulfur in gasoline fouls the catalytic converters installed on vehicles to reduce NOx emissions. It is important to note that in order to cut NOx emissions by the amount that acid rain and ozone science indicates is necessary to reduce environmental and health effects, no one action alone will suffice. Significant reductions are needed from electric generators and transportation sources beyond current clean air policies.

STATEMENT OF WILLIAM F. TYNDALL, VICE PRESIDENT OF ENVIRONMENTAL SERVICES, CINERGY CORPORATION

Good morning. Thank you for inviting me to testify before you on reauthorization of the Clean Air Act.

My name is Bill Tyndall. Since August 1998, I have been Vice President of Environmental Services for Cinergy Corporation, an electric utility company based in Cincinnati, Ohio that provides power to 1.4 million electricity customers and 470,000 gas customers in Ohio, Indiana and Kentucky. Prior to joining Cinergy, I served Representative John Dingell and other Committee Democrats as minority counsel to the House Commerce Committee and advised them on air quality issues. Still earlier, I was a senior policy advisor in EPA's Office of Air and Radiation. Still prior to that, I served in EPA's Office of General Counsel, where I worked on new source review and other stationary source issues under the Clean Air Act.

Thus, I am speaking to you today as someone who has spent nearly 10 years addressing air policy issues from a variety of perspectives. I am also speaking to you on behalf of the Edison Electric Institute, an association that represents investor-owned electric utilities such as Cinergy. I will be addressing what I see as the successes and the problems of the Clean Air Act as amended by Congress in 1990.

The Clean Air Act has proved effective at reducing air pollution in this country. Since the Act was adopted in 1970, emissions of the "criteria" air pollutants—sulfur oxides such as sulfur dioxide (SO_2), particulate matter, ozone, carbon monoxide, nitrogen dioxide and lead and their precursors (such as nitrogen oxides (NOx)) have fallen dramatically. While emissions of these pollutants from all industrial sectors have decreased, I will focus on those from power plants, a source category that is the focus of a large number of control programs under the Act. Consistent with the overall trend in emission reductions, emissions from power plants have fallen significantly since the Clean Air Act was adopted, and continue to decline as a result of the Title IV program for electric utilities adopted in 1990.

According to the Environmental Protection Agency, utility emissions of NOx, which had been 6.7 million tons in 1990, declined to about 6.2 million tons by the year 1997. By 2000, EPA projects that power plant NOx emissions will have declined by 2.1 million tons annually.

Between 1970 and 1997, SO_2 emissions resulting from fuel combustion by electric utilities declined by over 4 million tons a year (from a peak in 1980 of 17.5 million tons to 13.1 million tons in 1997). Once the second phase of the Title IV program is fully implemented, we project further significant declines in SO_2 emissions, to less than 10 million tons annually.

Electric utility particulate matter emissions have also declined substantially—by almost an order of magnitude (from 1.8 million tons in 1970 to 0.3 million tons in 1997).3 Virtually all coal-fired boilers in this country are now equipped with advanced particulate controls, including electrostatic precipitators (ESPs) and baghouses.

These emission reductions are even more remarkable when one considers that they have occurred during a period of substantial economic growth. This economic growth triggered concomitant growth in electricity production and use. For example, between 1970 and 1996, electric utilities experienced a greater than 120 percent growth in sales, from 1392 billion kilowatt-hours to 3084 billion kilowatt-hours. Nevertheless, the utility industry implemented control programs that substantially reduced emissions from all of their facilities—both new and existing.

But reducing emissions has not come cheaply. Information provided to the government by electric utilities on FERC Form No. 1 indicates that utilities and, as a result, their customers spent over $32 billion for air pollution control facilities between 1976 and 1996. Additional billions of dollars are being spent as the industry implements the second phase of the Title IV program. Utilities also bear the substantial, additional costs of operating and maintaining these pollution control facilities.

As even EPA recognizes, the costs associated with Clean Air Act compliance have increased over time. EPA estimates that annual costs to electric utilities for Clean Air Act compliance, which were $1.5 billion in 1985, had risen to $1.9 billion by 1990. The 1990 Clean Air Act Amendments increased these costs substantially. The SO_2 emission reduction program in Title IV alone has been estimated to increase the cost to electric utilities by up to $2.1 billion annually once it is fully implemented. There is every reason to believe that utility costs will continue to increase. Cinergy alone faces capital costs of up to $700 million for control of NOx emissions.

While I am on the subject of costs, let me point to one program that has helped to keep these costs—although high—lower than they would otherwise have been. I am referring, of course, to the market-based approach to reducing SO_2 emissions that is found in Title IV of the Act. Title IV has been a great success, with 100 percent compliance and substantial cost savings due to the flexibility of the program. Given the experience with Clean Air Act Title IV, I urge Congress to consider market-based approaches, as opposed to the traditional command-and-control approach to environmental regulation, whenever it considers reform or refinement of Clean Air Act emission reduction programs.

However, to call the Title IV SO_2 trading program a panacea is not correct either. Its success cannot be extrapolated to trading of NOx under EPA's SIP call, for example. Most of the SO_2 trading cost savings have come about as a consequence of lower prices of western low-sulfur coal and its transportation. A similar low-cost fuels fix is not available for NOx. In addition, the SO_2 program, unlike EPA's NOx SIP call, was designed in such a way as to maximize opportunities for trading. The SO_2 program was phased in over 10 years, while the NOx SIP call controls are due in less than 4 years. Furthermore, the SO_2 program required only a 50 percent reduction while the NOx SIP call requires an 85 percent reduction, which virtually mandates one type of emission control technology across most of the affected facilities. To maximize opportunities for NOx trading, the system should be modified to alleviate these problems.

While the Clean Air Act has been successful in terms of producing improved air quality, I would now like to focus on some aspects of the Act that, in my opinion, have made producing that improvement more burdensome and costly than necessary. In this regard, the Act features many programs that are directed toward the same pollutants from the same sources. This can result in increased administrative burdens to States and the regulated community, reduced compliance flexibility, greater difficulty in responding to changing market forces, and less cost-effective control requirements.

Let me illustrate my concern by referring to the many programs that are currently aimed at controlling NOx emissions from power plants. The statutory bases for controlling NOx emissions include the National Ambient Air Quality Standards (NAAQS) for ozone (of which NOx is a precursor) (CAA § 109), programs required to provide for the "attainment and maintenance" of the NAAQS (CAA §§ 110, 172, & 181–185), the Title IV existing source NOx reduction program (CAA § 407), the new source performance standard ("NSPS") program for NOx emissions from new sources (CAA §§ 111), the visibility improvement program (CAA §§ 169A & 169B), the new source review ("NSR") program (CAA §§ 165, 172 & 173), and a number of other programs.

For example, the Clean Air Act requires areas that do not attain the ozone NAAQS to implement "reasonably available control technology" for NOx emissions from major sources such as power plants (CAA § 172(c)(1)), and to have an overall plan for making reasonable, further reductions in NOx emissions in order to attain and maintain the standard (CAA § 110(a)(2)). The 1990 Clean Air Act Amendments added a number of specific NOx emission control requirements for power plants located in ozone nonattainment areas (CAA § 182).

In addition, new power plants are required to meet new source performance standards, and can be built only after being subjected to either "prevention of significant deterioration" (in attainment areas) (CAA § 165) or nonattainment review (in nonattainment areas) (CAA § 173). The same requirements apply to existing plants that are "modified" to create new capacity to emit air pollution beyond their original capacity. Title IV of the 1990 CAAA requires revision of the new source performance standards for NOx applicable to power plants (CAA § 407(c)).

Sections 169A and 169B of the Act require States to develop programs, pursuant to regulatory guidance issued by EPA, to address visibility concerns in the national parks. EPA just issued regulations in July of this year providing criteria for these State programs. These programs could address, among other things, NOx emissions from power plants.

The 1990 Amendments added an important new program addressing NOx emissions from existing power plants—the Title IV program. These new provisions im-

pose NOx emission limits on existing power plants covered by the Title IV acid rain provisions (CAA § 407(b)). These limits have been imposed in two phases, the second of which must be implemented by the year 2000.

EPA's implementation of these numerous, overlapping requirements that address NOx emissions from new and existing power plants has added to the complexity and cost of industry compliance efforts. For example, in 1997, EPA used the NAAQS provisions of the Act to promulgate a new ambient standard for ozone that was more stringent than the existing standard—the standard that serves as the basis for the specific NOx control programs Congress wrote into Subpart 2 of Title I of the Act in 1990. EPA has indicated that the new ozone NAAQS would be implemented largely through NOx controls. But while Congress specified a detailed program for reducing ozone levels in Subpart 2 of the Act—a program that addresses NOx as well as VOC ("volatile organic compound") emissions—the Agency indicated that it would not rely on that program when implementing the new NAAQS. The United States Court of Appeals for the District of Columbia Circuit understood the problems these inconsistencies posed and held that any new standard could not be implemented other than through the Congressional ozone reduction program.

At the same time that EPA has revised the ozone NAAQS, EPA has sought to use its Clean Air Act authority to review the adequacy of State Implementation Plans to develop a program for further NOx reductions for power plants in 22 States throughout the Eastern United States. This program is referred to as EPA's NOx SIP call rule. In many cases, the power plants affected by these NOx reduction requirements are far removed from the ozone nonattainment areas.

NOx reduction requirements could also be imposed on specific power plants in response to petitions filed by Northeastern States under § 126 of the Act. EPA has issued a rule which includes findings that would result in the automatic grant of these § 126 petitions, thereby triggering a 3-year compliance schedule, if States do not respond to EPA's NOx SIP call rule by November of this year. EPA has, however, temporarily stayed this rule while it undertakes additional rulemaking to "delink" the § 126 rule from the SIP call rule, thereby abandoning the Agency's earlier conclusion that the § 126 program should proceed only after States had an opportunity to consider additional control programs pursuant to the SIP call rule.

The utility industry is therefore confronted with numerous programs that address the same pollutant. Each program has potentially different implementation schedules. Each program raises different questions for a company's compliance planning. As you can imagine, this mix of programs and implementation schedules makes compliance planning exceedingly difficult and compliance itself unnecessarily expensive.

One key problem is that the differing programs may demand different technologies. A utility that invested in low NOx burners to meet its Title IV NOx requirements, for example, may also have to add Selective Catalytic Reduction (SCR) or Selective Non-catalytic Reduction ("SNCR"), or even switch to an alternative fuel such as natural gas, depending upon the schedule for and stringency of future requirements. The choice of technology is influenced not only by the stringency of and schedule for future requirements, but also by the nature of the implementation scheme. For example, will trading or banking of NOx emission credits be allowed, and under what conditions? These changing and uncertain requirements are both frustrating and costly for regulated industry and States.

Furthermore, because one program is not allowed to work before another is implemented, it is unclear that all of these overlapping programs are necessary from an environmental standpoint. For example, the detailed Congressional ozone control program contained in Subpart 2 of Title I reduced the number of ozone nonattainment areas by 62 percent (from 100 to 38) between 1991 and 1998.1 But EPA did not permit that program to come to fruition before adopting a new ozone NAAQS that would be implemented through a different program—under Subpart 1 instead of Subpart 2 of the Act. It is questionable that adoption of this new program will speed or enhance public health protection, but it certainly complicates planning for sources possibly subject to two NAAQS implementation programs.

Furthermore, while the previous discussion has addressed those portions of the Clean Air Act that concern power plant NOx emissions, the Clean Air Act contains numerous other programs addressing electric utilities that a company must consider in formulating its overall compliance strategy. I am providing with this testimony a chart that illustrates the myriad of new requirements that electric utilities face under the Clean Air Act regarding their emissions of SO_2 and NOx over the next decade. These include monitoring, reporting and control requirements for sulfur dioxide (SO_2) emissions; additional SO_2 emission reduction requirements under a possible short-term SO_2 ambient standard and a revised $PM_{2.5}$ standard; possible SO_2 and NOx limitations as part of regional haze programs; and revised new source re-

view requirements. Other regulatory programs that electric utilities may face include possible regulation of mercury emissions and possible future regulatory requirements targeting CO_2 emissions.

A company must also consider the possibility that legislation to restructure the electric utility industry could include new air quality programs. Because the system of air quality regulation is already so complex and burdened by a large number of programs addressing both new and existing power plants, I simply urge that restructuring legislation is not the place for more air quality legislation.

In sum, a company must evaluate its compliance plans in light of all of these programs—a daunting task given the continued regulatory uncertainty regarding many of them. The result could be commitments to expensive control technologies today for certain substances, which would be rendered useless during the next decade if new regulatory requirements dictate another compliance strategy, such as a switch to natural gas.

Finally, all of these difficulties are compounded by EPA's changing interpretations of key provisions of the Clean Air Act. For example, all of the regulatory programs discussed previously are being developed or implemented at the same time that EPA has proposed to change the Clean Air Act rule defining when an existing source is "modified" to such an extent that it must meet new source requirements, including NSPS and preconstruction permitting requirements under the PSD and nonattainment programs.

The Clean Air Act modification rule is perhaps the most complex and least understood of the Clean Air Act programs. EPA and the States have issued volumes of dense and sometimes conflicting guidance regarding the program. Indeed, EPA has recognized the confusing, cumbersome and byzantine nature of the NSR modification rules and is working with various stakeholders including industry and States to develop an appropriate fix.

This effort to develop a fix to the modification rule on which all can agree is critical, because EPA's recent efforts to reform this program have created tremendous confusion about the nature of repairs and activities that can be allowed at existing plants. Let me explain. Historically, EPA has stated Congress "did not intend to make every activity at a source subject to new source requirements," and that the Clean Air Act modification rule "in no way intends to discourage physical or operational changes that increase efficiency or reliability or lower operating costs, or improve other operational characteristics of the unit." By contrast, EPA explained in its July 1998 proposed revisions to the modification rule that the proposed rule changes would target activities undertaken "to increase reliability, lower operating costs, or improve operational characteristics of the unit," even if doing so would not result in any increase in the unit's emission rate.

This proposed change in the modification rule would strike at the heart of efforts to maintain the competitiveness of American industry in an international marketplace. For the utility industry, the proposed new approach to the modification rule would hinder the industry's efforts to optimize the reliability, efficiency and safety of its generating units at a time of declining electricity reserve margins. By discouraging such efficiency gains it is contrary to the Administration's goals of reducing greenhouse gases. Before proceeding with this rulemaking, therefore, it is critical that EPA take time to pursue the discussions with States, industry, and other stakeholders and that EPA take their concerns into account. EPA must adopt a modification rule that is clear and understandable, and that avoids unnecessary administrative and regulatory costs.

The electric utility industry recognizes that it has a responsibility to produce and supply the power this nation needs in an environmentally responsible manner. Its voluntary establishment and participation in the Climate Challenge program in partnership with the Department of Energy is evidence of its commitment to meeting that responsibility. This program will lead to 170 million tons of greenhouse gas reductions in the year 2000.

There are a variety of ways to achieve emissions reduction goals for this industry, while continuing to ensure a reliable and affordable delivery of electricity. EEI is working to develop new innovative approaches to dealing with these challenges. While I cannot speak for the entire industry, Cinergy strongly believes that Congress needs to replace the myriad of emission control programs aimed at utilities with a comprehensive approach that establishes a single set of reasonable reduction requirements with adequate lead times and market-based implementation mechanisms. This can be done in a manner that is consistent with the air quality and public health goals established in the Clean Air Act and that is more efficient, economic and provides more regulatory certainty than the existing piecemeal, uncoordinated approach that I have described today. And, along with such innovative solutions, we also need a significant increase in public/private partnerships for research

and development to identify the next generation of technology alternatives, and create incentives that will move us to even cleaner forms of electric generation in the future. But this will put this issue squarely before this Committee since it cannot be done without Congressional action.

With fair and clear environmental goals, appropriate timeframes, and flexible implementation, utilities can best determine a future course for their companies, be it pollution control installation or fuel switching or a combination that will give us the environmental solution we are striving to attain.

Air Quality Issues - NOx Controls *

· Title IV NOx Phase 1	1996
· NOx NSPS	1997
· NSR enforcement initiative	1999
· Title IV NOx Phase 2	2000
· NOx SIP call	2003
· NOx state petitions	2003
· U.S./Canada NOx treaty	2003
· Ozone (8-hour) NAAQS	2007
· PM2.5 NAAQS	2008
· Regional haze	2010
· Future NAAQS revisions	5 year intervals

* Dates reflect actual or potential implementation of emission controls.

Air Quality Issues - SO_2 Controls *

· Title IV SO_2 Phase	1995
· NSR enforcement initiative	1999
· Title IV SO_2 Phase 2	2000
· Possible short-term SO_2 NAAQS	2007
· Possible Title IV SO_2 Phase 3	2007
· PM2.5 NAAQS	2008
· Regional haze	2010
· Future NAAQS revisions	5 year intervals

* Dates reflect actual or potential implementation of emission controls.

STATEMENT OF MIKE BENOIT, CEMENT KILN RECYCLING COALITION

Introduction

Chairman Inhofe, Senator Graham and Members of the Subcommittee, good morning. Thank you for inviting me to testify at today's hearing on reauthorization

of the Clean Air Act. My name is Mike Benoit. I am Executive Director of the Cement Kiln Recycling Coalition (CKRC), a trade association representing cement producers that recover energy from hazardous wastes along with companies that provide equipment and services to cement manufacturers. As I'm sure you know, cement is the key ingredient in concrete which is an essential building material that is integral to our nation's infrastructure. In the United States, there are 118 cement plants located in 37 States. 52 of those plants use energy-bearing wastes as alternative fuels to fire their high-temperature cement kilns. Of those 52, 17 cement plants in 10 States recover energy from over 1,000,000 tons per year of regulated industrial waste materials in their high-temperature kilns, resulting in energy savings equivalent to roughly 22 trillion Btu per year, or the equivalent of more than 6 billion kilowatt-hours.

Today, this Subcommittee undertakes the difficult task of preparing for the reauthorization of the Clean Air Act. The statute is one of the most complex in U.S. environmental law and surely would benefit from some improvements. In that regard, there are some general principles that we hope will guide the Subcommittee as it proceeds. For example, regulatory action under the Act should:

adequately consider costs and risk reduction benefits; be derived from sound scientific principles that advance technological development;

be based upon consistent application and defensible interpretation of the law; be implemented and enforced in a manner designed to ensure predictability, fairness, and compliance; and

accommodate and encourage energy recovery technologies that reduce air pollution.

Our industry is subject to extensive regulation pursuant to the Clean Air Act. CKRC's member companies have very recently become subject to EPA's National Emission Standards for Hazardous Air Pollutants (NESHAPS): Final Rule for Hazardous Air Pollutants for Hazardous Waste Combustors (HWCs), or as it is called, the HWC Maximum Achievable Control Technology (MACT) rule, which was promulgated on September 30, 1999. (64 Fed. Reg., 52827, September 30, 1999) Our 6 years of experience with the development of the HWC MACTrule is the topic of my testimony today and is presented here as a case study that we hope can shed some light upon possible improvements to the Act, and to Section 112 in particular.

EPA did many strange and unprecedented things in the HWC rule. Unfortunately, many of them were aimed at achieving regulatory outcomes that could not be obtained by following the letter and spirit of Section 112 of the Clean Air Act. EPA focused on and pursued objectives that are plainly not authorized by the Clean Air Act as the Agency inappropriately invoked its RCRA authority or simply acted arbitrarily to go far beyond the provisions of Section 112 and its own internal precedents in previous CAA rulemakings. For reasons that will become clear, EPA became preoccupied with the competitive structure of the market for hazardous waste combustion and relied upon numerous unauthorized policy objectives which, ultimately, overwhelmed the regulatory process and led to the extraordinary decisions found in the final HWC rule.

Before proceeding further, however, we would particularly like to thank you, Mr. Chairman, along with Senators Hutchison, Graham, and Wyden for taking a particular interest in the oversight of the HWC MACT rule.

General Background

It is important to understand the nature of energy recovery in cement kilns and the environmental benefits that accrue. Under its RCRA Land Disposal Restriction rules EPA has mandated that certain categories of wastes must be burned—either in industrial furnaces (such as cement kilns), industrial boilers, or incinerators. EPA has also ruled that burning wastes in these types of combustion units is Best Demonstrated Available Technology (BDAT) for reducing or eliminating the hazards associated with those wastes. Cement kilns that recover energy from hazardous waste use these regulated materials as fuel—a one-for-one substitute for coal. More simply, kilns that recover energy from wastes are taking materials that EPA has said must be burned and converting them to productive use as a fuel in the cement manufacturing process. This technology yields many benefits:

- The nation's consumption of fossil fuel is reduced since less coal is burned; thus we're conserving our energy resources.
- Air pollution is significantly decreased because cement kilos replace fossil fuel with waste materials that EPA says must be burned. If cement kilns didn't or couldn't recover energy from these wastes, they would simply have to be burned elsewhere and the kilns would burn coal instead.
- Recovering energy from wastes in cement kilns reduces the amount of total combustion. That lowers emissions of carbon dioxide (C02) and thus lowers emis-

sions of greenhouse gases. Because of their chemical make-up, the waste materials burned in cement kilns also generate far lower emissions of sulfur oxides and nitrogen oxides (SOx and NOx).

The waste materials are put to productive use manufacturing Portland cement, the key ingredient in concrete, which is a critical construction material and absolutely essential to building and repairing our nation's infrastructure.

Air pollutants from cement kilns that recover energy from hazardous waste have been fully regulated since 1991. The members of CKRC recognize and accept that managing hazardous waste brings with it an obligation to society and that the public is well-served by our industry's excellent track record of compliance with comprehensive regulations designed to protect health and the environment.

Waste-burning cement kilns are subject to USEPA's 1991 Boiler and Industrial Furnace (BIF) Rule pursuant to the Resource Conservation and Recovery Act (RCRA). The BIF rules govern all aspects of processing, transporting, storing, and burning hazardous waste-derived fuels, and include stringent standards governing emissions of hazardous air pollutants. Upon promulgation in 1991, EPA lauded the BIF rule as fully protective of human health and the environment. In early 1993, EPA vigorously argued before the D.C. Circuit Court of Appeals that the BIF rules are fully protective. Since that time, there has been a massive amount testing of cement kiln emissions and extensive analysis of the risks associated with those emissions. Our industry has spent over $180 million complying with the BIF rule. We also have invested over $25 million on scientific, EPA-approved emissions testing and conducted at least 10 comprehensive risk assessments costing over $9 million. In addition, EPA and several State environmental agencies have conducted their own risk assessments. In every case, the emissions from cement kilns (including all those substances regulated as hazardous air pollutants (HAPs) by the HWC MACT rule) have been shown to be in compliance with the BIF rules and to pose no unacceptable risk to the surrounding communities. USEPA has possessed all of this data and information for several years.

Just 2 weeks ago, on September 30, 1999, our industry became subject to yet more EPA regulations when the Agency published the Hazardous Waste Combustor (HWC) Maximum Achievable Control Technology (MACT) Rule pursuant to Section 112 of the Clean Air Act (CAA). CKRC was deeply involved in monitoring this 6-year rulemaking and we provided extensive data and other technical information to EPA to assist the Agency in its regulatory development process.

History of HWC MACT Rulemaking

As you are aware, before EPA issued any MACT rules, the Agency prepared a response to the Congressional directives of Section 1 1 2(e) of the Clean Air Act by developing its Source Category Ranking System (SCRS) to evaluate the comparative risks posed by facilities. (58 Fed. Reg., 63941, December 3, 1993) Congress had instructed that "The Administrator should regulate first those categories or subcategories that he determines, based on the listed factors, present the greatest threat to public health." (H.R. Rep. No. 101–490, at 330 (1990) In its December 1993 schedule for promulgation of MACT rules based on its SCRS, EPA deferred regulating HWCs until November 15, 1997 or later. (58 Fed. Reg. at 63952–53) In contrast, EPA identified 45 other source categories as higher-risk than HWCs and scheduled them for MACT standard issuance by 1994.

EPA has thus concluded that HWCs, including cement kilns, are relatively low-risk sources of HAP emissions. That's not surprising since, as explained above, HAP emissions from cement kilns were already regulated under fully protective comprehensive RCRA standards. Despite this fact, the recently promulgated MACT standards for HWCs are unnecessarily stringent, very complex, and overly burdensome. The HWC MACT rule is about five times longer than other MACT rules. And the HWC MACT rule holds the record for the highest cost EPA has ever justified to meet a MACT standard. The semi-volatile metals emission standard for cement kilns has a cost effectiveness of $500,000 per metric ton of pollutants removed—almost 60 times higher than the average acceptable cost effectiveness in all previous MACT rules!

These extreme outcomes beg the question "Why did EPA do this?" It's a long story that will be fleshed-out below; but the short answer is that the Agency has been fixated on the competitive features of the thermal treatment market. In fact, in statements to the press in 1996, the Administrator explained that the HWC MACT rule would be designed to "level the playing field for hazardous waste incinerators." She also vowed to stop "allowing the competing cement kilns to undercut the commercial incinerators" in pricing. (See attached Appendix H. p.34 of CKRC's comments on the proposed HWC MACT rule, August 19, 1996.)

There obviously exists no statutory authority of any kind for EPA to interfere in waste management markets. And Section 112 of the CAA clearly instructs EPA to accommodate the technological differences among various source categories in setting MACT standards, even to the point of subcategorizing within a single source category. Nonetheless, in the HWC MACT rule, EPA was determined to carry out the Administrator's goals even if it had to override the clear directives of Section 112. The best example of this is that, after EPA established an SVM MACT floor level for incinerators of 240 micrograms/dscm, the Agency went to extreme measures to "justify" setting an identical, but relatively much more stringent 240 microgram/dscm SVM beyond the MACT floor standard for cement kilns. Voila! The HWC rule now contains uniform numerical standards for very different technologies and EPA has created the so-called "level playing field" the Administrator called for in 1996. As testament to the 'success' of the Agency's 'creation,' in a July 1999 briefing for Senate staff, EPA noted that the HWC MACT rule would leave cement kilns ". . .worse off due to the decline in market share and revenues, while commercial incinerators are projected to be better off due to the increase in prices, market share, and overall revenues." (See attached Overview of Hazardous Waste Combustor NESHAP Rule for Congressional Committees, July 1999) In the process, the intent of Congress was undermined.

As you know, Congress, including members of this Subcommittee, became aware in early 1998 of some of EPA's novel interpretations of Section 112 in the HWC rule and began conducting aggressive oversight over EPA's rulemaking process. Members of this Subcommittee were particularly concerned about the fate of energy recovery in cement kilns and the possibility that "if the [HWC MACT] rule is not sufficiently flexible, it may discourage this form of recycling." These Senators also asked EPA "to demonstrate that the proposed [cement kiln semi-volatile metal] MACT standard actually reduces risk over and above a MACT standard set at the floor." (See attached April 15, 1999 letter to USEPA from Senators Graham and Hutchison.) In all, members of the Senate EPW Committee sent four detailed letters to EPA over an eleven-month period and, in too many instances, the Agency either declined to respond or failed to respond substantively to the oversight inquiries (See attached letters from U.S. Senate to USEPA and EPA responses).

The many major flaws in the HWC MACT rule may prove instructive as this Subcommittee considers reauthorization of the CAA. CKRC believes its experience with the HWC MACT rule is unique and we hope this testimony may prove helpful in identifying provisions of the statute (particularly Section 1 12) that should be considered for amendment.

Specific Issues

The HWC MACT rule suffers from several defects that have their roots in three main areas: risk reduction/economic impact, scientific/technological basis, and jurisdiction. Also, the rule's implementation requirements are unduly complex and burdensome. Finally, the rule has no provisions designed to accommodate, encourage, or even recognize the environmentally beneficial recovery of energy from waste materials in existing industrial processes. In fact, it actually penalizes energy recovery technologies and seems designed to reduce the capacity of cement kilns to recover energy from hazardous wastes.

A. Risk Reduction/Economic Impact

Section 112 of the CAA authorizes EPA to set emissions standards that "shall not be less stringent, and may be more stringent than. . . the average emission limitation achieved by the best performing 12 percent of existing sources. . . " Such "more stringent" standards are called 'Beyond the MACT Floor Standards' or, simply 'Beyond the Floor' (BTF) standards. However, unlike MACT floor standards, BTF standards are subject to certain restrictions provided in Section 112(d)(2) wherein the Administrator must take into consideration "the cost of achieving such emission reduction, and any non-air quality health and environmental impacts and energy requirements. . . " In establishing MACT floor standards, Congress did not obligate EPA to consider costs and other factors. However, EPA is obligated to justify additional stringency beyond the MACT floor level. EPA has interpreted the provisions of Section 1 12 noted above as requiring that the Agency make a finding that a BTF standard is "cost effective". In past MACT rulemakings, EPA has been very sparing in promulgating beyond-the-floor standards. In the HWC MACT rule, on the other hand, EPA has published several BTF standards, some with cost effectiveness levels that exceed what has previously passed as cost effective by a factor of almost 60!

Because it is a clear example of what we believe is an abuse of the intent of the CAA, CKRC has been particularly concerned about the BTF standard EPA set for emissions of semi-volatile metals (SVM) from cement kilns. (In hazardous waste

combustors, due to the nature of the waste materials burned, a majority of SVM emissions are lead and the balance is cadmium.) In the final rule, EPA set a MACT floor SVM standard of 650 micrograms/dry standard cubic meter (dscm) for cement kilns. but decided to promulgate a much more stringent BTF standard of 240 micrograms/dscm. EPA's decision to set a BTF SVM standard for cement kilns was the subject of significant oversight by members of the Senate EPW committee. (See attached letters.) In the final analysis, EPA was completely unmoved by this committee's oversight and its frequently expressed concerns about the flawed analytical process, the lack of justification, and the possible negative consequences on energy recovery.

As noted above, in its past rulemakings, EPA has justified the establishment of BTF standards by finding them to be cost effective. Logic dictates that, implicit in such a finding, there should be some measurable environmental or public health benefit gained relative to the incremental costs of complying with a significantly more stringent standard. Historically, EPA has calculated the cost effectiveness of BTF standards in terms of dollars per ton of pollutant removed. In its previous decisions to promulgate BTF MACT standards, EPA's Of flee of Air and Radiation (OAR) generally has found acceptable cost effectiveness levels in the range of roughly $5,000–$14,000 per megagram (metric ton) of pollutant removed, with an average level of about $8,500 per metric ton. (See attached report, A Review of Economic Factors to use in PSD BACT Economic Analysis, Iowa Department of Natural Resources, p. 11, July 1998.) Cost effectiveness figures above that level generally have been found by OAR to be unacceptable. But the HWC MACT rule was not written by OAR, it was written by the Office of Solid Waste and Emergency Response (OSWER). For the BTF SVM standard for cement kilns in the HWC MACT rule, OSWER found acceptable a cost effectiveness of $500,000 per metric ton! That's almost 60 times more expensive than the average acceptable cost effectiveness levels in previous MACT rules!

In the final rule, EPA acknowledges "the relatively poor cost effectiveness of this standard" (64 Fed. Reg., 52882, September 30, 1999). The folly of EPA's acceptance of such an exorbitant economic impact on the cement industry becomes even more egregious in light of the complete lack of risk reduction gained by setting the more stringent BTF SVM standard. Although EPA frequently told stakeholders in this rulemaking that its decisions were being driven by concerns about children's health, in a June 7, 1999 letter to Senator Hutchison, EPA conceded that "we do not project a reduction in the numbers of children with blood lead levels the [sic] exceed the Centers of Disease Control and Prevention intervention level." (See attached letter from USEPA to Senator Hutchison)

Nonetheless, in the final HWC MACT rule EPA continues to claim that the beyond-the-floor SVM standard for cement kilns "supports our Children's Health Initiative." (64 Fed. Reg., 52882, September 30, 1999) In the final rule, EPA states that its "characterization of risks from lead focuses on the reductions in blood levels themselves and EPA's goal of reducing blood lead levels in children to below 10 micrograms per deciliter." (64 Fed. Reg., 53003, September 30, 1999) But, later, EPA describes the results of its analysis of the "excess incidence of elevated blood lead" attributable to HWCs and observes that "a small reduction (0.4 cases per year) is attributable to cement kilns." (64 Fed. Reg., 53008, September 30, 1999)

So, while EPA claims to have made its decision to go beyond-the-floor to improve the health of children, the Agency ultimately reveals that the benefit to children's health produced by the cement kiln BTF SVM standard is a decrease in the incidence of elevated blood lead levels of 0.4 cases per year. That's 0.4 cases out of the entire US population of over 250 million people! Surely all of us who support investments in the health needs of children should be dismayed by EPA's investment of 6 years in a regulation that will cost Americans millions of dollars to produce such a paltry result. In its comments on the HWC MACT rule, CKRC submitted a report to EPA showing that the literature contains abundant EPA and Centers for Disease Control and Prevention data that proves, by a wide margin, the most significant source of elevated blood levels in children is caused by exposure to lead-based paints in older housing. The dollars of additional cost that EPA has imposed on our industry with its BTF SVM standard would yield much greater public health benefits if applied to remediation of those lead-based coatings.

Combining OSWER's outrageous cost effectiveness findings with the results of its risk analysis reveals that the 240 microgram/dscm SVM standard for cement kilns is the single most expensive beyond-the-floor MACT standard ever promulgated by EPA. And the societal benefits gained are an incredibly miniscule and practically unmeasurable decrease in the incidence of elevated blood lead levels. By contrast, it's interesting to note that in 1995 OAR published a final MACT rule for secondary lead smelters. In that rule, OAR promulgated a MACT floor emission standard for

lead of 2000 micrograms/dscm, almost 10 times higher than the cement kiln SVM standard. And, because secondary lead smelters also are subject to regulation under RCRA, EPA examined the risk factors and specifically concluded in the secondary lead smelter rule that the standard of 2000 micrograms/dscm was fully protective of human health and the environment and, therefore, the Agency's RCRA obligations were satisfied.

These are examples of the inconsistent and extreme results that can ensue when EPA is allowed to arbitrarily mix the authorities of different statutes and employ unauthorized policies to arrive at decisions that contravene Congressional intent. Clearly, the abuses found in the HWC MACT rule demonstrate that any reauthorization of the Clean Air Act ought to include a significant revision of Section 1 12, especially as it relates to beyond-the-floor MACT standards. Absent specific guidance from Congress regarding acceptable economic impacts and risk reduction targets, and without tight limitations on the Agency's rulemaking procedures, the spirit and intent of the Clean Air Act can and will be undermined.

B. Science and Technology

As cited above, Section 1 12 of the Clean Air Act specifies that emissions standards for existing sources ". . . shall not be less stringent, and may be more stringent than the average emission limitation achieved by the best performing 12 percent of existing sources. . . " Emissions standards that are not "less stringent" are generally referred to as "MACT Floor" standards. "More stringent" standards are called "Beyond-the-Floor" standards. In accordance with the statute, both types of emissions standards are technology-based standards. This is as opposed to risk-based standards that EPA is authorized to promulgate under other statutes, such as RCRA.

In its previous MACT rulemakings for industrial source categories, EPA has developed MACT floor standards by assessing the performance of the various control technologies employed to control emissions of hazardous air pollutants (HAPs). Typically, this involves assembling an inventory of the technologies in existence followed by analysis of a body of data that describes the performance of those technologies. As specified by the CAA, EPA is supposed to use the analysis to determine "the average emission limitation achieved by the best performing 12 percent of existing sources." For example, EPA evaluates the performance of a control technology designed to capture emissions of a particular HAP by analyzing data that describes the emissions capture rate of specific air pollution control devices (APCDs) or other technologies. By following what is supposed to be a very prescriptive process, EPA then determines which APCDs represent the "best performing 12 percent" and establishes the MACT floor emissions standard at that level of performance. Clearly, an important part of Congress's intent in the CAA and in Section 1 12, is to create pressure on industry to upgrade its air pollution control systems and processes and, thereby, advance the scientific development of more effective technologies to reduce air pollution. Stated simply, Congress intended the CAA to be a science-based, technology-forcing statute.

In the HWC MACT rule, EPA claims to have followed the prescribed procedure for establishing MACT floor levels for the various HAPs at issue in this rulemaking (dioxins/furans, mercury, metals, chlorine and hydrogen chloride). But, in many cases, OSWER went beyond the established procedure previously developed and implemented by OAR and employed unprecedented and highly questionable techniques to set the MACT floor levels for HWCs. For example, to set emissions standards for metals, EPA identified what it refers to as "feedrate reduction" of metals as a 'control technology' that is uniquely available to hazardous waste combustors. The Agency evaluated this "control technology" by lumping all units in each subcategory together, hand-picking the individual combustion units that just happened to have the lowest metals feedrates, and then anointing them as "best performers." Basically, EPA 'discovered' that the way to control emissions from HWCs is to cause them to reduce the amount of waste they can burn—even though HWC's that burn hazardous waste are playing a critical role in managing that waste! That type of 'emissions control' doesn't come close to advancing the scientific development of more effective pollution control technologies and has nothing whatsoever to do with the "best performing" technologies.

Some additional context is needed to fully appreciate the implication of this decision by EPA. In several of its RCRA rules, EPA has acknowledged that, other than combustion, there are no known technologies to separate metals from certain combustible hazardous waste streams. In fact, EPA mandates that these types of wastes must be combusted in regulated HWCs. One way or another, these materials must be burned in a regulated unit such as an incinerator, a cement kiln, or a boiler. (Recall that, in its RCRA rules, EPA has specified combustion as the Best Dem-

onstrated Availability Technology for these waste streams, in full recognition of the fact that they usually contain metals.)

So this "control technology" (i.e., feedrate reduction) contrived by OSWER amounts to little more than a device for rewarding those facilities that burn less hazardous waste and penalizing those that (for whatever reason) burn more waste. Thus, the practical effect of implementing feedrate reduction as a control technology is to force facilities to burn less waste—in the case of cement kilns, to reduce their energy recovery capacity and burn more coal. If fully extended to a manufacturing process such as an oil refinery, this type of logic implies that the "best performing" oil refinery would be the one that feeds no crude oil to the unit. EPA's approach would mean that the best performing refineries are the ones out of business. There simply is no legitimate rationale in the Clean Air Act for this type of approach to setting MACT standards and, in fact, the approach used by OSWER in the HWC MACT rule is wholly without precedent in other CAA MACT rulemakings.

The real travesty here is that, by defining feedrate reduction as a technology, EPA has shredded Congressional intent and made a mockery of bona fide air pollution control technologies. In the HWC rule, the Agency has ignored the intent of the CAA to promote scientific development of air pollution control technologies by declaring that a legitimate and proper solution to the problem of controlling air emissions is as simple as just feeding less material into a process. Because if you don't put it in, it won't come out. What a discovery! What a great leap forward! Played out to its full extent, EPA's logic in the HWC MACT rule would mean that shutting down industry could best solve America's air pollution problems.

In the HWC MACT rule, EPA cites the provisions of Section 112 (d)(2)(A) that allow "substitution of materials or other modifications" as its authority for using feedrate reduction as a control technology. EPA argues that cement kilns can comply with the more stringent BTF SVM standard simply by using less hazardous waste for energy recovery and "substituting" it with coal—thus increasing both the total amount of combustion and overall emissions of air pollutants. OSWER claims this is consistent with the spirit and intent of the CAA. But the Agency never explains why feedrate reduction has never been used by OAR in any other CAA rule.

CKRC would like to suggest that this Subcommittee and, eventually, Congress take steps in the reauthorization of the CAA to require that EPA implement the Act using only legitimate scientific rationales. EPA should be prevented from conjuring-up unprecedented techniques to justify emissions standards that are more stringent than could ever be derived by conventional data analysis as applied to bona fide air pollution control technologies. In particular, Congress should ensure that reducing inputs to processes can never be claimed as a "control technology," especially in the case of energy recovery applications that result in a decrease in air pollution. Finally, Congress should require that EPA not attempt to abuse its CAA authority to try to manipulate competitive markets.

C. JURISDICTION

The EPA office traditionally charged with implementing the CAA is the Office of Air and Radiation (OAR). Aside from the Phase I and Phase II MACT rules affecting combustion of hazardous waste, all other MACT rulemakings promulgated by EPA (including several relating to other types of waste combustion) have been or are being developed by OAR. The HWC MACT rule (in its various phases) is the only one that has been or will be developed by OSWER.

As we have seen, this jurisdictional anomaly proved instrumental in creating a mechanism for EPA to circumvent CAA authority and the intent of Congress and, by invoking supposed "RCRA concerns," enabled the Agency to promote its unauthorized policy objectives relating to the hazardous waste combustion market. CKRC is convinced that the HWC MACT rule would not suffer from its unusual defects had the regulatory development process been in control of the more experienced Office of Air and Radiation. It has been common knowledge that this rulemaking produced a huge donnybrook between OAR and OSWER and that the arguments were, in part, related to OSWER's disregard for precedent established by OAR in implementing the CAA. Historically, in its development of other MACT rules, OAR has at the very least exercised some restraint in its interpretation of the statute and achieved a degree of regulatory consistency across its CAA rulemakings. Surely we know of no cases where OAR attempted to use the CAA to affect the competitive structure of markets. Unfortunately, the HWC MACT rule became a vehicle for OSWER to inject the Agency's biases into the thermal treatment market and, apparently, the Office felt unconstrained by either the CAA or Senate oversight in pursuing that objective.

In its reauthorization of the CAA, this subcommittee should consider adding provisions that will prevent this kind of abuse in EPA's implementation of the Act. Congressional intent would be better served by the creation of some type of barrier to preclude EPA from claiming "joint statutory authority" to develop CAA regulations, or to use CAA regulations as an outlet for unauthorized policy initiatives, particularly those that run counter to the intent of the Act.

Implementation and Compliance

Ultimately, the efficacy of any regulatory action is tied to its implementation. Successful implementation is the means by which compliance with a rule is achieved and maintained and by which environmental gains are realized.

The HWC MACT rule, as noted above, is extraordinarily complex, almost punitively so. Its complexity is not linked to positive environmental or public health outcomes; but only encumbers the implementation of the rule. It is regulatory burden that has been laid-on for its own sake. Early in the HWC rulemaking, in 1996, EPA conducted several public meetings during which it touted the extent to which the rule would be designed to simplify and consolidate many requirements of the existing RCRA rules that governed hazardous waste combustors. EPA claimed that the discomfort and expense of the stringent standards the Agency intended to develop would be offset by more efficient, less redundant, and simpler implementation requirements. EPA did not fulfill its commitment. What we got instead are much more stringent standards and much more complicated implementation requirements.

In its deliberations about CAA reauthorization, Congress should take into consideration that the current statute does not adequately compel EPA to use common sense in its rulemakings. EPA apparently needs Congressional guidance to force the Agency to more substantively bind itself to issuing common sense, uncomplicated implementation procedures and requirements. Congress should impress upon EPA the need to implement CAA rules in a way that encourages and even hastens compliance among the regulated community. Congress should let EPA know that successful implementation, pursued by cooperative and interactive means, would produce a higher rate of compliance at less burden and lower cost. Congress should charge EPA with the obligation to rely much more on assistance than on enforcement to ensure compliance and give the Agency the tools necessary to carry out that task.

Energy Recovery

Since the mid-1980's, the US cement industry has productively used millions of tons of hazardous waste as fuel in cement kilns. Congress has made clear in other statutes (e.g., RCRA) that it is environmentally preferable to recycle the value of waste materials than to destroy or dispose of them. The benefits provided by recovering energy from wastes in existing manufacturing processes that were enumerated at the beginning of this testimony are real. Fossil fuels are conserved. Air pollution is significantly decreased. And waste is converted to a productive asset. It is clearly a win-win proposition.

But the commercial hazardous waste incinerator operators didn't see it that way. Until the early 1990's they had enjoyed a near-monopoly in the hazardous waste combustion market. Their reaction to what they perceived as emerging competition from cement kilns was to aggressively lobby EPA to increase the regulatory burden on their cement industry competitors, thus increasing their costs and, as a hoped-for byproduct, reducing their presence in the hazardous waste thermal treatment market. Their mantra was "level the playing field," despite the well-known fact that cement kilns were newly subject to the BIF rules, which were far more comprehensive than the RCRA Subpart O standards for incinerators. The incinerator companies, primarily via their trade association, the Environmental Technology Council (ETC), finally began to see their lobbying efforts gain traction in the early days of the current Administration. After several closed-door meetings with incinerator operators early in her tenure, Administrator Browner seized upon ETC's rhetoric and initiated her "Hazardous Waste Combustion Strategy" in May 1993. That immediately resulted in EPA abandoning its vigorous defense of the RCRA BIF rules in the D.C. Circuit and produced an out-of-court settlement with ETC that, among other things, committed the Agency to issue tighter regulations on cement kilns that recover energy from hazardous waste. (See CKRC Comments on the Proposed HWC MACT Rule, Appendix H. August 19, 1996)

In its zeal to regulate cement kilns with much tighter emissions standards in the HWC MACT rule, EPA acted as though it was unconstrained by the CAA from making decisions that were specifically aimed at reducing the capacity cement kilns to recover energy from hazardous wastes. As cited above, the Administrator set EPA upon a course to use the HWC rule to stop "allowing competing cement kilns to un-

dercut the commercial incinerators." And that's just what the Agency did. It established exotically expensive beyond-the-floor standards and then specified that cement kilns could achieve compliance with those standards by "feedrate reduction," i.e., by burning less waste for energy recovery. (Because EPA mandates that the waste must be burned, if cement kilns burn less waste, incinerators will burn more waste.) In its formal comments on the proposed rule, CKRC aggressively challenged EPA's decision and, in oversight communications, members of this Subcommittee also emphatically objected to the Agency's approach. In response, EPA claimed on the one hand that it was not obligated to consider the HWC MACT rule's impact on energy recovery capacity; and, on the other hand, that it rejected our industry's data and information as incorrect (i.e., not in conformance with EPA's analysis).

It ought not to be so easy for EPA to completely disregard the important environmental ramifications of recovering energy from millions of tons of waste. We believe the CAA should be amended to specifically support and encourage energy recovery and other recycling activities that have been shown to directly benefit air quality and reduce greenhouse gas emissions. EPA should be barred from taking any regulatory action under the Clean Air Act that impairs, reduces, or otherwise adversely affects energy recovery technologies that have demonstrable environmental (and economic) benefits. Conversely, the CAA should require that EPA take affirmative steps to promote and encourage such technologies. CKRC hopes this Subcommittee will be inclined to fill this void in the Clean Air Act.

Conclusion

The Subcommittee today has a rare opportunity to begin afresh its analysis of the Clean Air Act as it contemplates reauthorization. Our recent experience with the MACT program dictates that Congress should be vigilant of several points in dealing with this section of the Act. First, Congress should make clear the findings necessary to go beyond the MACT floor in setting emissions standards. While CKRC believes the law already adequately requires EPA to make cost and other findings to justify standards more stringent than the floor, Congress should take the opportunity of reauthorization to make the importance of cost and risk considerations even clearer to the Agency. Second, Congress must make clear that reducing feed to a process is not a control technology or a gauge of the best-performing sources, that it does not amount to an application of sound science, and that it does not promote technological advancement in accordance with the intent of the Clean Air Act. Third, Congress should take steps to guard against the MACT program being used as a thinly veiled attempt to reallocate market share or make production decisions for the regulated community. Fourth, Congress should remind the Agency that neither the regulated community nor the environment are served if rules are implemented in inflexible ways. Rather, common sense in implementation makes compliance more likely and less expensive, and better protects human health and the environment. And finally, Congress should ensure that the CAA accommodates and encourages proven energy recovery technologies and prohibits EPA from actions harmful to the perpetuation or expansion of those technologies.

Thank you again for this opportunity to testify before the Subcommittee. I look forward to answering any questions you may have.

CEMENT KILN RECYCLING COALITION (CKRC)

APPENDIX H

CKRC's Concerns with the underlying policy choices and motivations which give direction to the proposed rule

As these comments demonstrate, it is obvious that EPA's proposal is based upon many legal, policy and technical choices that are unprecedented and of questionable validity (if not plainly illegal or invalid). At every opportunity, EPA has chosen a path that will lead to exceedingly stringent, onerous and expensive requirements for cement kilns that burn hazardous waste. It is apparent that this has been a result-oriented process. That is, EPA's prime motivation has been to impose great additional costs on cement kilns, and EPA has crafted MACT and RCRA legal, technical and policy choices to support this pre-ordained result.

As shown below, prior to May, 1993, EPA had steadfastly defended the current BIF rules as fully protective of human health and the environment and had stated several times that they are sufficiently conservative to allay any rational concerns over "indirect" exposure risks. Moreover, EPA Regions and the State of Texas have recently confirmed these points. Also R-VII RA letter of 7/17/95 to Ms. Mary King:

"EPA believes the requirements of the BIF rule are protective of human health and the environment."

Rather, two related rationales quite clearly are driving the proposed cement kiln standards. They are in fact the only rationales that can provide a cohesive logical explanation for what would otherwise be irrational Agency behavior:

1. EPA is being driven from the top to make hazardous waste combustion a more expensive and less attractive option in a misdirected attempt to force U.S. industry to reduce its generation of hazardous waste ("waste minimization" or "source reduction"); and

2. Among the competing forms of hazardous waste combustion, EPA's leadership has most obviously favored commercial incineration interests against cement kilns. EPA's leadership is in fact attempting to aid the incinerators by "leveling the playing field" vis-a-vis cement kilns on the pricing front.

As we will show below, these twin driving rationales are beyond EPA's legal authority. When EPA's stated MACT and RCRA legal and policy choices are seen in this light, it makes them all the more fundamentally flawed and unacceptable. EPA is simply trying to achieve its unauthorized goals of source reduction and playing-field leveling by stretching its MACT and RCRA legal theories to unacceptable lengths.

First, we will present a brief review of EPA's development of rules and policies. Second, we will review the evidence of EPA's favoritism toward commercial incinerator interests. Third, we will show that the most basic activities and policies that appear to be driving EPA's proposal are contrary to law, and they taint all the basic MACT and RCRA legal positions articulated by EPA in support of its proposal.

2. EPA Political Preferences for Commercial Incinerators

a. Competition Between Cement Kilns and Commercial Incinerators

Many types of common industrial wastes are accepted and safely treated by both cement kilns and commercial incinerators. They are in competition for a significant amount of the same "market share" for treatment of this waste. Cement kilns have an inherent market advantage, as cement kilns use HWDF as a replacement for fossil fuel that would otherwise have to be purchased, and cement kilns obtain most of their revenues from their cement product that is sold in commerce. A commercial incinerator makes no product, however, and burns hazardous waste for purposes of destruction rather than as a valuable fuel replacement.

Cement kilns can readily pass on the savings to their industrial waste generating customers. For many types of industrial hazardous waste, the industrial generator can save a significant amount on its waste treatment costs, and the wastes will be treated equally if not more effectively, by sending them to a cement kiln as opposed to a commercial incinerator facility.

There are thus great benefits to the burning of hazardous waste in cement kilns. The environment benefits because the kilns provide capacity to safely treat many of the nation's industrial hazardous wastes. The nation's precious and limited natural resources benefit because fossil fuels that would otherwise be burned are replaced by the energy-bearing HWDF. American industry benefits economically by having an option to meet its environmental legal requirements that is far less expensive than the commercial incineration option. Moreover, the option of cement kilns burning waste benefits conditionally exempt small quantity generators (CESQGs) since an economical and environmentally safe alternative to disposal is offered.

The fact that cement kilns provide such a superior economical and environmental alternative to commercial incinerators has led to a situation in which cement kilns have far surpassed commercial incinerators in capturing markets for many types of hazardous wastes in the last few years. This has in turn caused some leading commercial incineration companies to engage in aggressive tactics to attack cement kilns burning hazardous waste.

b. AFRTT, ETC. and Their Allies

One such organization is the "Association For Responsible Thermal Treatment" ("AFRTT"). AFRTT has hired three formerly elected officials to serve as "co-chairs" to spearhead those anti-cement kiln efforts. One of the three co-chairs, and most visibly active, is James J. Florio, recently the Governor of New Jersey. AFRTT, its member companies (principally Rollins Environmental Services, Inc., the nation's largest commercial incineration company), and other associations of commercial incinerator companies have initiated a vicious and wholly unprincipled.war against cement kilns on many fronts for several years, and the war has intensified greatly in the last 2 years.

Simply put, AFRTT has used the regulatory arena in which to fight its market battles. The cement industry has burned more hazardous waste than the commercial incineration industry in the past 2 years. Consequently, the incinerators interests have used environmental issues in an inaccurate manner in an attempt to regain market share.

The more traditional litigation arm for the commercial incinerator companies is now known as the Environmental Technology Council ("ETC"). This litigating association's name was changed to ETC in 1994. Before that, ETC was called the Hazardous Waste Treatment Council ("HWTC") for a number of years.

One tactic AFRTT, ETC/HWTC, and Rollins have long employed is to help create and/or support so-called "citizens groups" to publicly front the incinerators' competitive efforts to oppose cement kilns that burn HWDF and to provide the incinerators' "standing" to sue in Federal courts.

For instance, the American Lung Association received two AFRTT "grants" of $110,000 and $150,000 in 1994 and 1995. Even though cement kilns burn hazardous waste just as safely and efficaciously as commercial incinerators, and are more stringently regulated, the American Lung Association (ALA) has used the AFRTT grants to direct funds to local chapters for the purpose of opposing cement kilns burning hazardous waste. Not surprisingly, ALA has never initiated a similar program to oppose commercial incinerators burning hazardous waste.

There can be no question that these "citizen" groups have been formed to oppose the burning of hazardous waste in cement kilns, and that issues of relative stringency of environmental standards are secondary if not irrelevant concerns to these groups. A leader of one of the most vocal of these groups—the Huron Environmental Activist League (HEAL)—has stated in a newsletter to similar groups that HEAL "was formed in 1991 to oppose the burning of hazardous waste at the Lafarge cement plant in Alpena." Attachment 2. This HEAL leader utilized the imagery of war and the emerging militia movement in the United States to bolster the troops' morale:

When it crystallized for me that this cement kiln incineration war was not going to be a short "firelight" but instead a protracted, grinding and dirty conflict that would change boys into men and girls into women in a hurry and those who wouldn't or couldn't grow up, including myself, would be casualties upon whose forgotten bones some other warrior someday might raise the flag of victory . . . at that point, I promised myself that I would not become a casualty. I had already lost much and some of what I lost is sadly irrevocable.

The war is no longer isolated local or regional "nimby" skirmishes. *It is a civil war.* Government "for the people" is at stake, and we all have to survive locally to get the job done on the national front.

In Michigan the war is raging.

(emphasis added).

This "war" has been a coordinated campaign by the citizens militia and the commercial incineration interests, and the coordination has manifested itself in national litigation and rulemaking efforts, as well as in local campaigns. In the same document on the status of the war, the HEAL leader further stated:

With every local battle won the entire theater of war shifts in our favor. In the last year and a half there have been victories that would have been unthinkable 4 years ago . . . like the eight non-compliant BIFs losing interim status as a result of the Citizens Petition, Holnam abandoning their plans to burn in Montana, the vacating of Tier III and the suspension of burning in Alpena, the imminent fall of waste-burning at National Cement in Lebec, California, the EPA Roundtables and the CKD Report to Congress, the ARTT[AFRTT]/Lung Association grants, and on and on.

The reference to "BIFs losing interim status as a result of the Citizens Petition" refers to one such coordinated effort. On January 31, 1994, HEAL, Desert Citizens, Adans, and the commercial incinerators' ETC (then HWTC) filed a "Petition For Administrative Action to Cease Hazardous Waste Burning" with EPA against several cement kilns that were then burning or proposing to burn HWDF. This petition did not seek to impose any particular standards on such kilns. Rather, as its title indicated, it was simply aimed at stopping the kilns from burning hazardous waste.[5] EPA granted the relief the petitioners sought in some cases and denied it in others.

[5] The petition did not attempt to stop kilns from applying for a permit to burn hazardous waste under RCRA, but inasmuch as this permit process takes many years, each location where the petition was successful would be sure to stop hazardous waste burning for a long, indefinite time.

The reference to the "vacating of Tier III" refers to the result of litigation efforts by citizens groups and the ETC (then HWTC) in Horsehead. In that case, the groups

jointly sought review of EPA's BIF Rules that regulate the burning of hazardous waste by cement kilns and other types of furnaces and boilers.

The reference to the "ARTT[AFRTT]/Lung Association grants" refers to the fact that the commercial hazardous waste incinerator interests have sometimes even openly and directly funded citizens groups who will oppose cement kilns burning hazardous waste fuel—in addition to providing them legal representation through commercial incineration industry staff and outside counsel.

c. Political Favoritism to Incinerators at Top Levels of EPA

It has become obvious over the last 3 years that at the highest political levels of EPA, there is great favoritism and access for the commercial incinerator interests in their war against cement kilns. One good example is EPA's process in issuing its recent "determination" for cement kiln dust (CKD). 60 Fed. Reg. 7366, February 7,1995. For groups whose primary interest is simply to stop the burning of hazardous waste in cement kilns, it is entirely logical that they would push for full Subtitle C regulation of CKD in an uncompromising manner. As EPA has found, the costs of such controls would be exceedingly burdensome and oppressive, and many if not most cement kilns now burning HWF would likely be forced to quit doing so if full Subtitle C regulation over CKD were imposed. Id. Even if a kiln could afford to absorb such wholly unnecessary costs, it would (to the great satisfaction of the commercial hazardous waste incineration industry) substantially drive up the costs of sending hazardous wastes to cement kilns for safe and effective treatment.

When EPA originally published the CKD Report and solicited public comment for the CKD Regulatory Determination, the agency properly held a round of meetings between EPA personnel and various interest groups. At the cement industry meeting with EPA, EPA personnel stated in no uncertain terms that after the deadline for public comment—March 8,1994—EPA would have no further meeting with any interested parties in the CKD Regulatory Determination.

This policy was breached almost immediately when EPA Assistant Administrator Laws met with an anti-cement kiln group organized and promoted by the commercial incinerators industry shortly after March 8. Cement industry counsel protested this meeting in a letter to EPA counsel on March 14, 1994. (Attachment 3). Cement industry counsel asked whether EPA had changed its policy and said that if so, "we would certainly appreciate the opportunity to meet." To this day, EPA has never responded to the cement industry's March 14,1994 letter.

CKRC later learned that there were two such meetings in March. The EPA summaries of such meetings (Attachment 4) show that the cement kiln enemies raised not only CKD issues but also lobbied hard for tough new MACT emission standards for cement kilns at their meetings.

The AFRTT political connection with EPA leadership has continued to alarm CKRC. On May 9,1994, former Congressman and former Governor Jim Florio (now AFRTT co-chair) sent EPA Administrator Browner a "Dear Carol" letter explaining why—in his view—a recent U.S. Supreme Court decision required EPA to regulate CKD under RCRA Subtitle C. Attachment 5. Mr. Florio's letter was on his new law firm's letterhead and nowhere in the letter did Mr. Florio disclose that he had recently become co-chair of AFRTT.[6]

[6]As shown In our counsel's letter to Ms. Browner of May 11, 1994 (Attachment 6), we believe Mr. Florio's legal views were totally incorrect.

On October 20, Mr. Florio wrote another letter to Ms. Browner. (This time he at least made clear he was writing on behalf of AFRTT.) He urged the Administrator to meet with him to discuss AFRTT's goal of providing for -"more appropriate environmental regulation of the cement kiln industry." (Attachment 7).

CKRC wrote Ms. Browner on November 30, 1994 to express its concern over this new AFRTT attempt at an ex parse communication on the CKD issue. Attachment o. CKRC reiterated that EPA personnel had stressed there could be no more Meetings after the close of the comment period on March 8, 1994, and asked whether she was planning to meet with Mr. Florio. CKRC stressed that out of fairness, she should meet with the cement industry if she met with AFRTT. Neither Ms. Browner nor anyone else in EPA has ever responded to CKRC's November 30,1994 letter.

On December 21, 1994, CKRC obtained a copy of an AFRTT press release. In that release, AFRTT announced that its representatives had met with Assistant Administrator Laws on December 21,1994. The release makes clear that AFRTT continued to press its CKD points as well as many MACT points with Mr. Laws during flus meeting. Attachment 9.

On December 23, 1994, CKRC wrote yet another letter to Ms. Browner. Attachment 10. CKRC expressed its disappointment that she had never answered CKRC's November 30 letter and spoke of CKRC's "grave concern" over the obvious pattern that was developing of EPA giving preferential ex parse treatment to the commer-

cial incinerator interests while totally ignoring CKRC's letters and requests for meetings.

The situation portrayed in CKRC's letter to Ms. Browner of December 23 turned out to be much worse than CKRC initially realized. Not only did Ms. Browner's staff arrange for Mr. Florio and his AFRTT people to meet with Mr. Laws on December 23, they also arranged for two additional ex parse to press EPA to regulate CKD from kilns that burn HWDF under full Subtitle C on the very same day! MACT issues were also prominent on the agenda for these meetings.

One meeting was with a group of citizens promoted (and partially funded) by AFRTT that met with Mr. Laws. (In the war-time missive discussed above, the HEAL leader closed by saying: "Hope to bring back good news from the D.C. meeting with Elliott Laws." Attachment 2.) Another meeting was a contingent from Rollins Environmental Services, Inc., a prime member of both ETC and AFRTT and unquestionably the most vicious attacker of cement kilns that burn HWDF. Rollins met with Deputy Administrator Hansen. The EPA summaries of such meetings are attached at Attachment 11.

To this day, neither Ms. Browner nor anyone else at EPA has ever responded to CKRC's letter of December 23. Thus, EPA personnel had told CKRC representatives that after March 8, 1994 (the close of the public comment period on the CKD determination), there would be absolutely no more meetings with any interest groups to discuss the pending determination. The incinerator interests nevertheless were granted at least five separate meetings (possibly more) with high-level EPA personnel to influence EPA to take action on CKD that was extremely adverse to the cement industry and to conduct further MACT propaganda activities. CKRC's letters of protest and requests for rebuttal meetings went totally unanswered (and are unanswered to this day), and CKRC never obtained a single meeting with EPA during this period.

Another example of this anti-cement kiln coordination between commercial incinerators and citizen groups—and EPA's blatant political-level favoritism toward the incinerators and their cohorts—is the Horsehead settlement agreement described above. Even though they lost the one major issue they actually litigated in Horsehead the commercial incinerator interests were able to "negotiate" a Settlement Agreement with EPA to resolve several issues that were withdrawn from oral argument at the eleventh hour. Even though CKRC was a party in Horsehead and the Settlement Agreement has a significant detrimental effect on the cement industry, CKRC was never invited to or even informed about the closed-door meetings leading up to the Settlement Agreement, EPA never had similar meetings with CKRC, and EPA never even gave CKRC the opportunity to comment on the Settlement Agreement before it was filed with the court.

d. EPA's Assistance to AFRTT In Playing-Field Leveling

Another example of the EPA leadership's siding with the commercial incinerators relates to the so-called "leveling of the playing field." First, through all of their dozens of political contacts and ex parse meetings, the AFRTT forces appear to have convinced the Administrator that commercial incinerators are more stringently regulated than cement kilns under current EPA rules. As shown above, nothing could be further from the truth. EPA's Director of the Office of Solid Waste recently confirmed this in a letter to AFRTT of May 30,1996.

Yet on July 28, 1995, the Administrator appeared on the MacNeil/Lehrer News Hour on the Public Broadcast System television network. On that show, she stated:

Let me explain what's happened in this country. We have one set of standards for hazardous waste incinerators. We have another, weaker set of standards for cement kilns, boilers, industrial furnaces—which are also burning hazardous waste. I think we should have tough standards for both. That's exactly what my rule would do. What David sought to do today in his amendment—which he lost would have been to prohibit me from setting tough standards on these facilities that are burning hazardous waste. Why should there be two different standards, a lesser standard for some?

The Administrator was openly challenged by Congressman McIntosh (the "David" referred to in her statement), but she continued to insist that cement kilns were subject as a "lower standard" than incinerators.

A well-known AFRTT slogan is that EPA should "level the playing field" in the economic competition between commercial incinerators and cement kilns. This slogan in part is used to argue (absolutely falsely) that EPA's standards for cement kilns are not as comprehensive and stringent as those for commercial incinerators, and that if EPA would force even more stringent standards on cement kilns, somehow the "playing field" of the competition would become "level."

More pointedly, behind the AFRTT "playing field" pitch is the desire to force greater costs upon cement kilns that burn hazardous waste. The desired result would be that much greater costs would force some of the AFRTT's cement kiln competitors to stop burning hazardous waste. For those that continued to burn, the point is that greatly increased compliance costs would translate into higher prices for generators and work to level the market pricing playing field to AFRTT's advantages.

EPA's Administrator has apparently been influenced by AFRTT's pitches. As reported in news accounts, Ms. Browner explained that her current proposal for cement kilns "will level the playing field for hazardous waste incinerators." BNA Daily Environment Reporter, March 21, 1991, at A-33. Ms. Browner also vowed to stop "allowing the competing cement kilns to undercut the commercial hazardous waste incinerators" in pricing. Id.

Another news account stated:

In a conference call with reporters, Browner said that the new emission limits would level the playing field among hazardous waste incinerators and hazardous waste-burning cement kilns.

BNA Daily Environmental Reporter, March 22,1996, at A–29.

Certainly AFRTT has publicly recognized and thanked EPA's Administrator for her support. In a letter of May 23, 1996 to suppliers and customers, the President of Rollins (AFRTT's prime member) reviewed AFRTT's long-standing campaign to level the playing field in the market place vis-a-vis cement kilns. (Attachment 13.) The Rollins President made the following statements:

Thanks in part to AFRTT's issues advocacy work in Washington, D.C. and nationwide, EPA Administrator Carol Browner recently proposed tough new emissions standards for all hazardous waste combustion devices, including cement kilns, under the Clinton Administration's National Combustion Strategy. The Administrator has acknowledged AFRTT's [AFRTT's] work as being the most important catalyst for quick issuance of this important proposal.

The Rollins letter also mentions several "AFRTT Accomplishments." Among those listed are:

- Issuance of EPA's proposal for Maximum Achievable Control Technology (MACT) standards for hazardous waste combustors; and
- Building of significant credibility with EPA through several years of meetings with EPA Administrator Browner and other senior EPA officials coupled with AFRTT's visible support for EPA initiatives.

Moreover, AFRTT co-chair James Florio commended the Administrator for her close team-work with AFRTT, according to this news report:

"The EPA has done an excellent job in putting together this proposed rule which advances environmental protection while at the same time balancing the economic burden of regulation," Jim Florio, ARTT [AFRTT] co-chair and former New Jersey Governor, said in a March 20 statement. "Carol Browner, in particular, is to be commended for her leadership within the administration on moving this proposal ahead."

In prepared statements both ARTT [AFRTT] and EPA mentioned proposed amendments to EPA's fiscal 1996 appropriations bill that would have limited EPA' ability to implement the 1993 combustion strategy, of which this proposed rule is one component. The riders were strongly supported by the cement kiln industry. BNA Daily Environmental Reporter, March 21,1996, at A–35

Another example of EPA's bias toward the commercial incinerators is worth mentioning. CKRC filed a rulemaking petition with EPA respecting hazardous waste fuel issues on February 10, 1994. The petition sought EPA clarification on some issues that are very important to the cement industry. To this days despite requirements in RCRA and EPA's own regulations the only acknowledgment CKRC has ever received is a "Return Receipt Requested" green card. By contrast, the Hazardous Waste Treatment Council (now ETC) filed an anti-cement kiln petition with EPA 10 days earlier—on January 31, 1994. By April 4, 1994, EPA had taken final action on that petition that gave the commercial incinerators much of the relief (against cement kilns) that they had requested.

United States Senate

WASHINGTON, DC 20510

September 14, 1998

The Honorable Carol Browner
Administrator
U.S. Environmental Protection Agency
401 M Street, SW
Washington, DC 20460

Dear Administrator Browner:

As part of our oversight responsibilities as members of the Senate Committee on Environment and Public Works, we have been reviewing the rulemaking process for the maximum achievable control technology ("MACT") standard for hazardous waste combustors ("HWCs"). On June 25, 1998, U.S. Environmental Protection Agency ("EPA") staff briefed Environment Committee members' staff on the status of this MACT rulemaking. Based upon that briefing, we have the following questions:

Emissions Standards

1. Please explain in detail the methodology that you have selected for calculating the HWC MACT floor emissions limits for semivolatile metals from HWCs. Do you intend to use the same methodology for all regulated units? If not, why not? Identify the specific control technologies and design criteria which comprise MACT for HWCs.

2. In the proposed HWC MACT rule, EPA identified feedrate limitation as a MACT floor technology (in addition to particulate matter (PM) control) for control of semivolatile metals emissions from cement kilns. Have you ever selected feedrate limitation as a control technology in any previous MACT rulemakings? If so, please identify the specific rulemaking(s) and the Agency's supporting rationale. If not, please explain the technological attributes of HWCs (as opposed to, for example, secondary lead smelters) which support the Agency's conclusion that SVM feedrate limitation is a MACT floor technology.

3. In 1995, EPA finalized a MACT rule for secondary lead smelters that included a lead emission limit of 2,000 micrograms per cubic meter and specified the MACT control technology as particulate matter control using a fabric filter. In comparing this rule with the HWC rule under consideration now, several questions are evident. First, the emission limit in the MACT rule for

secondary lead smelters is almost 10 times higher than the HWC cement kiln semivolatile metal limit. What is the technical rationale for this difference? Second, it appears that beyond-the-floor controls were not considered for secondary lead smelters while they are being considered for the HWC rule. Please identify the reasons for this difference. Third, EPA has identified feedrate limitation as a control technology for HWC's but not for secondary lead smelters. Both secondary lead smelters and HWCs are fed metal hazardous air pollutant-bearing waste materials at controlled rates. Why is feedrate limitation not a control technology for secondary lead smelters?

Continuous Emission Monitors ("CEMs")

1. You have stated that you intend to require the installation and use of PM CEMs to demonstrate compliance with the PM emissions standards in the HWC MACT rule. It is our understanding that EPA has conducted demonstration testing on a single hazardous waste incinerator and that the efficacy of the CEMs tested is a matter of some controversy among the regulated industry. Please provide the technological support for the Agency's assumption that demonstration of PM CEMs on an incinerator provides an adequate basis for concluding that the devices will perform reliably and accurately for compliance purposes on other types of HWCs such as cement kilns.

2. You have frequently cited the use of PM CEMs in Europe (especially Germany) as evidence of the units' acceptable performance. In Germany the data output of PM CEMs are used as indicators of compliance, and facilities' recorded deviations from regulatory standards are used by regulators as a mechanism to encourage sources to improve their performance. In contrast, in the United States, the EPA would regard a deviation from a standard or permit limit as an exceedance which would constitute a violation resulting in penalties. In light of the disparate applications and consequences of PM CEMs in Europe and the proposed US approach, please explain the basis for your reliance upon European examples as evidence of the workability of PM CEMs in the US regulatory environment.

3. You have proposed HWC MACT PM standards that are derived from data collected via manual test methods, and you have stated your intention to require the use of PM CEMs to demonstrate compliance with the manual method-based PM standards. How does this approach comport with the U.S. Court of Appeals for the D.C. Circuit which held that, "a significant difference between techniques used by the agency in arriving at standards, and requirements presently prescribed for determining compliance with standards, raises serious questions about the validity of the standard." (Portland Cement Association v. Ruckelshaus, 486 F.2d 375, 396 (D.C. Cir. 1973))?

Thank you for your timely consideration of these questions. Given the short timeframe for the MACT rule, with transmission of the draft rule to the Office of Management and Budget imminent, we would appreciate a written response to these questions within two weeks.

Sincerely,

James M. Inhofe

Bob Graham

Ron Wyden

Jeff Sessions

United States Senate

WASHINGTON, DC 20510

February 11, 1999

Mr. Timothy Fields, Jr.
Acting Assistant Administrator
Office of Solid Waste and Emergency Response
U.S. Environmental Protection Agency
Washington, D.C. 20460

Dear Mr. Fields:

On September 14, 1998, we sent a letter to Administrator Carol Browner regarding the proposed rule on Hazardous Waste Combustion Maximum Achievable Control Technology (HWC MACT rule). You responded on her behalf in a letter dated November 6, 1998 (the November letter). We believe the November letter fails to fully answer several important points and we have additional questions.

1. We understand that the database in the HWC MACT rulemaking record contains no evidence of a general correlation between semivolatile metal (SVM) feedrates and air emissions of SVMs from HWC cement kilns. Does EPA's Office of Solid Waste and Emergency Response (OSWER) now have data establishing such a correlation? If such data exist, please provide us with all relevant information to that effect. Identify the criteria used by OSWER to include or exclude any given feedrate used at any given site. Please also provide any information that may demonstrate that SVM feedrate is a reliable indicator of site-specific SVM air emissions. Include any information in the rulemaking record that indicates that SVM feedrate may not be a reliable indicator of site-specific SVM air emissions (e.g., Are there instances when stack test data for a particular facility show that air emissions decreased when feedrate increased, or vice versa?).

2. Recently we have heard that EPA's Office of Air and Radiation ("OAR") threatened to "nonconcur" with OSWER's desire to set a "beyond the floor" (BTF) SVM standard for cement kilns and that there has been significant debate on this issue between OAR and OSWER. As we understand it, this proposed BTF standard is significantly more stringent than the floor standard of 670 $\mu g/dscm$ for cement kilns that EPA described in its May 2, 1997 notice of data availability ("May 7, 1997 NODA"). 62 Fed. Reg. 24212. We have heard that the BTF standard would be in the range of 200-300 $\mu g/dscm$.

So that we may better assess what has occurred on these important matters in the HWC MACT rulemaking, please provide us with answers to the following questions and with all relevant documents.

a. Since publication of the May 2, 1997 NODA, has OSWER developed a draft final rule that would impose an SVM standard on HWC cement kilns in the range of 200-300

$\mu g/dscm$ (or any other figure significantly lower than 670) that would be based on a BTF approach? If so, provide a full description of the rationale for such a possible BTF standard, and provide all documents relating to such a possible BTF analysis and standard. Please also describe the calculated floor level that existed at the time OSWER conducted any BTF analyses and considered promulgating a BTF standard, and provide all documents relating to the basis for the SVM floor level being considered at that time.

b. Since publication of the May 2, 1997 NODA, has OSWER developed a draft final rule that would impose an SVM standard on cement kilns in the range described in Question (a) that would be based on a MACT floor in that range? If so, provide a full description of the rationale for such a possible floor level standard, and provide all documents relating to such a possible floor calculation and standard.

c. Has staff or management in OAR or any other EPA office ever disagreed with OSWER's calculation of or methods for developing the SVM floor level for cement kilns, or OSWER's BTF analysis for SVM for cement kilns? If so, describe these differences (including the floor levels or BTF analyses at issue), and provide all documents relating to such differences.

d. Has staff or management in OAR or any other EPA office ever "nonconcurred" or threatened to "nonconcur" during or prior to workgroup closure or Red Border review concerning the SVM standard for cement kilns? If so, explain the basis for the nonconcurrence or threatened nonconcurrence and, to the extent any documents concerning such actions by any EPA office are not within the scope of the other document requests in this letter, please provide all such documents. Please also describe any changes to the HWC MACT rulemaking package made as a result of any differences, nonconcurrences, or threats of nonconcurrence expressed by OAR or any other EPA office, regardless of whether they concerned the SVM standards, and provide all documents indicating or relating to such changes.

Thank you for your continued cooperation in this important oversight activity. Because of the short time frame apparently in place for consideration of this rule, we must ask you to respond to these questions by February 28, 1999.

Very truly yours,

James M. Inhofe
United States Senator

Ron Wyden
United States Senator

United States Senate

WASHINGTON, DC 20510

April 15, 1999

The Honorable Carol Browner
Administrator
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, DC 20460

Dear Administrator Browner:

As members of the Senate Committee on Environment and Public Works Subcommittee on Clean Air, we have taken an active interest in the oversight of many proposed Clean Air standards. It is our understanding that EPA has sent its proposed Hazardous Waste Combustion (HWC) maximum achievable control technology (MACT) standard to the Office of Management and Budget soon. In part, this MACT standard will apply to cement kilns that recover energy from waste. Therefore, if the rule is not sufficiently flexible, it may discourage this form of recycling. This would appear to be inconsistent with sound principles of environmental protection.

We are particularly concerned that EPA may set the MACT standard beyond the floor it has calculated for the average of well-performing cement kilns. Indeed, when you appeared before our Committee on February 24, you stated your intention "to develop tools and data that will move the air toxics program from an almost exclusively technology-based program to a risk-based program." Please explain what data you have used to demonstrate that the proposed MACT standard actually reduces risk over and above a MACT standard set at the floor. How can you be certain that reduced pollution prevention won't outstrip any risk reduction you hope to achieve? It seems that the proposed MACT rule may be inconsistent with your statement of February 24.

Thank you for your prompt attention to this matter, and we look forward to your reply.

Sincerely,

Kay Bailey Hutchison

Bob Graham

United States Senate

WASHINGTON, DC 20510

June 15, 1999

Mr. Donald Arbuckle, Director
Office of Information & Regulatory Affairs
Office of Management & Budget
Old Executive Office Building, Room 10201
Washington, DC 20503

Re: Hazardous Waste Combustion MACT Rule

Dear Mr. Arbuckle:

It is our understanding that the Office of Management and Budget ("OMB") is currently reviewing the maximum achievable control technology ("MACT") standard for hazardous waste combustors ("HWCs"). Because of the impact this rule can have on energy recovery policy and the goals of both air and waste policy, we also have been interested in its progress. As members of the Senate Environment and Public Works Committee, we have been engaged in a lengthy oversight initiative. In meetings, phone calls, and letters to EPA, we have raised questions about aspects of the rulemaking, especially as they pertain to HWC cement kilns which, as you know, recover energy from hazardous wastes in the cement manufacturing process. These four principal issues relate to:

1. The fact that this Clean Air Act MACT rule, unlike all others, has been written by EPA's Office of Solid Waste (OSW) rather than the Office of Air and Radiation (OAR).

2. EPA's unprecedented identification of "feedrate reduction" as a control technology.

3. The Agency's decision to set a "beyond-the-floor" MACT standard for SVM emissions from HWC cement kilns.

4. EPA's plans with respect to certain compliance monitoring requirements.

The following further elaborates on these issues.

1. We question why OAR, the EPA office responsible for developing regulations implementing the Clean Air Act (CAA) Amendments of 1990, has not led the effort to develop the HWC MACT rule. OSW has had no direct experience with regulations pursuant to the CAA and our oversight efforts have produced information that indicates OSW may be creating precedents and making regulatory decisions that are at odds with previous MACT rules. In addition, it raises a question why OSW, due to its familiarity with regulations under the Resource Conservation and Recovery Act (RCRA), may be attempting to justify these unusual approaches to writing technology-based MACT standards by unauthorized but non-existent issues that have no basis in the CAA.

2. Since the original proposal of the HWC MACT rule in April 1996, EPA has identified what it refers to as "feedrate control" as a control technology to be used to achieve compliance with the emissions standards. In effect, OSW has taken the unusual and, to our knowledge, unprecedented step of defining the pool of best performing facilities by, at least in part, selecting combustion facilities with atypically low feedrates of certain substances such as metals. OSW also seems to be attempting to establish the achievability of MACT standards by specifying reduction of material feedrate (*e.g.*, hazardous waste-derived fuel) to a process. While it may seem intuitive that a process that feeds less of a particular substance will emit less of that substance to the air, such a theory should form the basis for technology-based standards under the Clean Air Act MACT provisions. At the very least, such a theory would have to be fully supported by data in the rulemaking record. The Agency's responses to recent oversight inquiries by this Committee indicate to us that EPA does not have data that incontrovertibly supports its theory. We thus question whether OSW, in an effort to establish certain numerical emissions limits, may be employing techniques that will erode the longstanding foundations of previous MACT rulemakings and weaken the overall framework of Clean Air Act regulations.

3. We have been informed by EPA that it is considering setting beyond-the-floor (BTF) standards in the HWC MACT Rule. Specifically, we have questions whether the Agency intends to set a BTF standard for semivolatile metals (SVM---primarily Lead) emissions from HWC cement kilns without proper regard for the potential societal costs of such action. As you know, BTF standards are relatively rare in MACT rulemakings and the CAA mandates that any such standards be proven to be cost effective. In the most recent previous MACT rules written by OAR that established standards for semivolatile metals or Lead, EPA has rejected BTF limits (e.g., MACT rules for Municipal Waste Combustors (MWCs), Medical Waste Incinerators (MWIs), and Secondary Lead Smelters (SLSs)). In the HWC MACT Rule, EPA published a Notice of Data Availability (NODA) in May 1997 wherein OSW indicated that it was "unlikely" that a finding of cost effectiveness could be made to support a MACT standard more stringent than the MACT floor level of 670 micrograms/dscm. EPA's responses to our most recent oversight letters have produced no evidence that EPA has data to support a credible cost effectiveness finding for a BTF standard for SVM and, also important, the Agency seems to have data indicating that there is no measurable risk reduction benefit to be gained by such a standard. We question whether EPA's decision to set a BTF SVM limit for cement kilns is a result of policy directives unauthorized by the Clean Air Act and whether it will jeopardize the economic viability of energy recovery programs in the cement industry.

4. Finally, we question whether the EPA is attempting via this rulemaking to bootstrap requirements to install Particulate Matter Continuous Emission Monitors (PM CEMs) despite the fact that these devices have not been proven to reliably function for compliance demonstration purposes on all types of HWCs. In addition, it seems that EPA proposed to require a very short-term monitoring frequency for compliance with the dioxin/furan standard that is incompatible with the test methods used to obtain the data underlying the standard itself. In both cases, there seems to be no justification for EPA's decisions in the context of proper rulemaking under the CAA.

In conclusion, we hope that OMB can benefit from the efforts already underway at oversight of the

HWC MACT rule in the U.S. Senate. We believe OMB should carefully examine whether EPA adhered to law and precedent established under the Clean Air Act. Nothing less will save the HWC MACT rule from lengthy legal challenge, inconsistency with established public policy goals, and a general lack of credibility. Please let us know if you have further questions or if you need additional information.

James M. Inhofe
United States Senator

Ron Wyden
United States Senator

cc: Mr. Art Fraas
Mr. Eric Haxthausen
Ms. Tammy Croot (Room 10202)
Office of Information & Regulatory Affairs

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

NOV 06 1998

OFFICE OF
SOLID WASTE AND EMERGENCY
RESPONSE

The Honorable Ron Wyden
United States Senate
Washington, DC 20510

Dear Senator Wyden:

Thank you for your letter of September 14, 1998 to Administrator Browner regarding the rulemaking process to develop maximum achievable control technology (MACT) standards for hazardous waste combustors (HWCs) under the Clean Air Act and the Resource Conservation and Recovery Act. In your letter, you posed several questions related to the emissions standards and continuous emissions monitoring systems for particulate matter (PM CEMSs). We are responding to these questions in detail below.

As of this date, the HWC MACT rulemaking is still in the deliberative phase. We therefore request that you preserve the confidentiality of this document by refraining from providing copies or otherwise communicating its contents to persons other than those with a need to know as part of the Congressional oversight review. The final rulemaking package is undergoing internal Agency review and must also must undergo a three month review by the Office of Management and Budget prior to signature by the Administrator. Therefore, the responses contained herein should be viewed strictly as recommendations of the Office of Solid Waste and Emergency Response to internal Agency workgroup members, and not as final Agency action or as final policy determinations by the Administrator.

Emission Standards - Committee Issue 1

a) Please explain in detail the methodology that you have selected for calculating the HWC MACT floor emissions limits for semi-volatile metals (SVM) from HWCs.

b) Do you intend to use the same methodology for all regulated units? If not, why not?

c) Identify the specific control technologies and design criteria which comprise MACT for HWCs.

EPA Response to 1a: Explain the methodology for calculating MACT floor limits for SVM.

Please see Enclosure A ("Methodology for Identifying MACT Floors"), which presents a detailed description of the methodology being used for determining SVM floors.

EPA Response to 1b: Does EPA intend to use the same methodology for all regulated units?

At the outset, it is important to keep in mind that the HWC rulemaking encompasses three separate source categories of facilities that burn hazardous waste -- incinerators, cement kilns, and lightweight aggregate kilns (LWAKs). Furthermore, this rulemaking involves setting eight sets of standards to control the hazardous air pollutants (HAPs) set forth in Clean Air Act § 112. These standards address dioxins/furans, mercury, semi-volatile metals (SVM - lead and cadmium), low volatility metals (LVM - arsenic, beryllium, and chromium), particulate matter, total chlorine, carbon monoxide, and total hydrocarbons.

During the four-year span of this rulemaking, we considered various data analysis approaches for determining MACT floor levels, including some that might have been fairly uniform across the three source categories or fairly uniform among the HAPs or HAP groups. Many of these approaches were published in the Federal Register for public comment, and voluminous comments were, in fact, received on the issue of data analysis methodologies. See, for example, Notice of Data Availability, 62 FR 24212 (May 2, 1997).

We have found that a single data analysis method is appropriate for our SVM floor determination. Our reasoning is that, for each of the source categories, the Agency was able to perform the same analysis and that each of the source categories uses the same type of floor control (i.e., PM control combined with hazardous waste feedrate control of SVM).

EPA Response to 1c: What are the specific control technologies and design criteria which comprise MACT for SVM?

For hazardous waste incinerators, MACT floor control for SVM is use of a fabric filter, electrostatic precipitator, or ionizing wet scrubber to control PM to the PM floor emission level, plus control of the feedrate of SVM (i.e., lead and cadmium) in the hazardous waste to a specified level representative of MACT floor control. Of course, a source would not have to use MACT floor control to be in compliance with a floor standard. Rather, the source would be required to demonstrate compliance with an emission level the Agency determines is being achieved in practice by sources using floor control.

For hazardous waste cement kilns, MACT floor control for SVM is use of a fabric filter or electrostatic precipitator to control PM to the PM floor emission level, plus control of the feedrate of SVM in the hazardous waste to a specified level representative of MACT floor control.

For hazardous waste LWAKs, MACT floor control for SVM is use of a fabric filter to control PM to the PM floor emission level, plus control of the feedrate of SVM in the hazardous waste to a specified level representative of MACT floor control.

Emission Standards - Committee Issue 2

a) In the proposed HWC MACT rule, EPA identified feedrate limitation as a MACT floor technology (in addition to particulate matter (PM) control) for control of semivolatile metals emissions from cement kilns. Have you ever selected feedrate limitation as a control technology in any previous MACT rulemakings?

b) If so, please identify the specific rulemaking(s) and the Agency's supporting rationale. If not, please explain the technological attributes of HWCs (as opposed to, for example, secondary lead smelters) which support the Agency's conclusion that SVM feedrate limitation is a MACT floor technology.

EPA Response to 2a and 2b

To my knowledge, the Agency has not identified feedrate limitation as a control technology in a previous MACT rulemaking. However, as discussed in detail in Enclosure B ("Rationale for Using Hazardous Waste Feedrate Control as MACT Floor Control"), a number of legal and technical factors have led us to conclude that HWCs are today controlling SVM emissions through feedrate and that this provides an acceptable basis upon which to determine MACT floor levels. For example, every cement kiln and LWAK and many incinerators are currently operating under feedrate limits for lead and cadmium established under RCRA regulations.

Emission Standards - Committee Issue 3

a) First, the emission limit in the MACT rule for secondary lead smelters is almost 10 times higher than the HWC cement kiln semivolatile metal limit. What is the rationale for this difference?

b) Second, it appears that beyond-the-floor controls were not considered for secondary lead smelters while they are being considered for the HWC rule. Please identify the reasons for this difference.

c) Third, EPA has identified feedrate limitation as a control technology for HWCs but not for secondary lead smelters. Both secondary lead smelters and HWCs are fed metal hazardous air pollutant-bearing waste materials at controlled rates. Why is feedrate limitation not a control technology for secondary lead smelters?

EPA Response to 3a: Why is the MACT lead emission limit for secondary lead smelters almost 10 times higher than the SVM limit for cement kilns?

In setting MACT standards for a given source category, the Agency uses emissions data and/or other pertinent information specific to that source category. Any difference between the emissions limit for lead in the secondary lead smelter (SLS) rule and the lead contribution to the

recommended SVM floor emission level in the HWC MACT rule is primarily due to differences in the emissions data or other information used to identify the technology basis for the MACT standard.

As discussed in Enclosure A and in the proposal (59 FR 29760, June 9, 1994) and final rule (60 FR 32587, June 23, 1995) for secondary lead smelters, EPA determines the floor as being the average emission limitation achieved by: 1) the best-performing 12 percent of existing sources for categories with 30 or more sources; or 2) the best-performing 5 sources for categories with fewer than 30 sources. Because the emissions data and control practices for each type of unit differ, it follows that applying a floor methodology to each data set would result in different floor levels, which is simply a reflection of the different levels of metal feedrate and control now in existence at facilities in each category. Thus, the MACT lead floor standard for SLSs is almost 10 times higher than the recommended HWC SVM emissions floor standard for cement kilns.

EPA Response to 3b: It appears that beyond-the-floor controls were not considered for SLSs while they are being considered for the hazardous waste rule. Why?

The Agency considered, and ultimately rejected, beyond-the-floor controls for organic HAPs for the blast furnace-only SLS configuration. For all other SLS configurations, EPA determined that no control options more stringent than the floor were available for consideration for control of organic or metal HAPs.

For the HWC MACT rule, the Agency has determined that control options more stringent than floor control (i.e., additional feedrate control of metals) are available and appropriate for consideration as BTF controls for SVM. When setting MACT standards, we believe our obligation under section 112 of the Clean Air Act is to consider both existing controls for setting the floor and also any other reasonable controls that can be used to achieve a more stringent, BTF emission level. In this case, many HWCs are already subject to metals emissions limits, including for SVM. This is true for all cement kilns and LWAKs and a number of incinerators. As noted earlier and in Enclosure B, these facilities currently measure and control metals in their hazardous waste feed as a means to comply with existing limits.

The Agency's opinion is that, based on current practices in these source categories, it is reasonable to investigate a further, BTF reduction in the feedrate of metals like SVM. (In fact, such consideration appears to be mandated given the express language of Section 112(d)(2)(A), as discussed further in Enclosures A and B.) This decision has been subject to full public notice and comment in both our initial MACT proposal (61 FR 17358) and notices of data availability (NODA): NODA 2 (Revised emissions database) - January 7, 1997: 62 FR 960; NODA 3 (MACT standards and implementation) - May 2, 1997: 62 FR 24212.

EPA Response to 3c: Why is feedrate limitation not a control technology for SLSs?

At the time of the SLS proposal (June 9, 1994), SLSs were only subject to new source

performance standards to limit emissions of PM, and to state regulations enacted to prevent violation of the National Ambient Air Quality Standards for lead. In addition, about one-half of smelters were subject to permit conditions for lead developed under the Prevention of Significant Deterioration provisions of the Clean Air Act. Under these requirements, SLSs were not required to set permit feedrate limits for lead. As a result, they typically met the NAAQS limits under State implementation plans by using air pollution control technology (i.e., fabric filters). As a result, EPA used fabric filters without feedrate control as the basis for its MACT determinations in the SLS rule.

Moreover, it appears illogical to limit the amount of lead going into a lead smelter as a means of controlling emissions. These facilities exist solely to recycle lead. Therefore, feedrate controls have not been applied to SLSs and did not exist as a basis for determining floor controls in the SLS rulemaking. Hazardous waste combustors, on the other hand, burn hazardous waste as fuel (e.g., cement kilns) or treat hazardous waste by destroying organic compounds (e.g., incinerators). Lead is unnecessary to their operations. Combustors have, and have exercised in the past, the option of choosing which hazardous waste materials to burn in order to limit the cost of emissions control technologies required on their stacks.

Because the regulatory circumstances and technical factors for the HWC rulemaking are different from those present at the time of the SLS proposal, the Office of Solid Waste and Emergency Response is recommending that hazardous waste feedrate be used, entirely or partially, to determine floor levels and beyond-the-floor levels for SVM.

CEMSs - Committee Issue 1

Please provide the technological support for the Agency's assumption that demonstration of a PM CEMS on an incinerator provides adequate basis for concluding that the devices will perform reliably and accurately for compliance purposes on other types of HWCs such as cement kilns.

CEMSs - Committee Issue 2

In light of the disparate applications and consequences of PM CEMS in Europe and the proposed US approach, please explain the basis for your reliance upon European examples as evidence of the workability of PM CEMS in the US regulatory environment.

CEMSs - Committee Issue 3

You have proposed HWC MACT PM standards that are derived from data collected via manual test methods, and you have stated your intention to require the use of PM CEMS to demonstrate compliance with the manual method-based PM standards. How does this approach comport with the U.S. Court of Appeals for the D.C. Circuit which held that, " a significant difference between techniques used by the agency in arriving at standards, and requirements presently prescribed for determining compliance with standards, raises serious questions about the

validity of the standard." (Portland Cement Association v. Ruckelshaus, 486 F.2d 375, 396 (D.C. Cir 1973))?

EPA Response to CEMSs Issues 1, 2, and 3

The Agency is not planning to include in the final HWC MACT rule a requirement for the installation or use of PM CEMS for compliance with the PM emissions standard. The Agency is currently working with the regulated industry to gather additional PM CEMS data. Currently, EPA has begun installation of 2-3 PM CEMS on a cement kiln operated by Lafarge in Fredonia, Kansas. This testing coupled with future testing by the Office of Air Quality, Planning and Standards in conjunction with the American Portland Cement Alliance will provide long-term PM CEMS data upon which the Agency plans to develop a CEMS-based PM standard. The Agency also is working with a hazardous waste burning lightweight aggregate kiln and a hazardous waste burning incinerator to initiate similar testing programs to gather additional PM CEMS data for these source categories.

I hope that this information fulfills your needs. If additional information is required or questions arise, please contact George Hull in our Office of Congressional and Legislative Affairs at (202) 260-7808.

Sincerely,

Timothy Fields, Jr.
Acting Assistant Administrator

Enclosure A

Methodology for Identifying MACT Floor in HWC Rulemaking

General Background

EPA has identified hazardous waste incinerators, hazardous waste cement kilns, and hazardous waste lightweight aggregate kilns as source categories to be regulated under Section 112 of the Clean Air Act. The Agency therefore must develop maximum achievable control technology (or MACT) standards for each category to control emissions of hazardous air pollutants. Under section 112, the Agency may distinguish among classes, types and sizes of sources within a category in establishing such standards.

Section 112 prescribes determination of a minimum baseline or "floor" as the first step for establishing MACT standards. For new sources, the floor levels for a source category cannot be less stringent than the emission control that is achieved in practice by the best-controlled similar source. Section 112(d)(3). The floor levels for existing sources may be less stringent than standards for new sources, but cannot be less stringent than the average emission limitation achieved by: (1) the best-performing 12 percent of existing sources (for which the Administrator has emissions information) for categories with 30 or more sources; or (2) the best-performing 5 sources (for which the Administrator has emissions information) for categories with fewer than 30 sources.

The Agency also must, as appropriate, consider a more stringent level than the floor, referred to generally as a "beyond-the-floor" standard, as part of its determination of a final MACT standard. Here, EPA must evaluate the maximum degree in reduction of HAPs determined to be achievable taking into account the cost of achieving those reductions, non-air quality health and environmental impacts, and energy costs. Section 112 (d) (4). The object is to achieve the maximum degree of emission reduction without unreasonable economic, energy, or secondary environmental impacts. Sometimes, a preliminary inquiry suggests that these beyond-the-floor controls are not in common use, may have significant technical questions in terms of full-scale, full-time performance, may involve extreme costs to install and operate, and/or may involve only small incremental emission reductions over that achieved at floor levels. After analysis of these factors (and any others that might be relevant), the Agency may determine that it is not necessary or appropriate to pursue a more detailed beyond-the-floor analysis.

Details on Floor Methodology in HWC Rulemaking for Existing Sources

The starting point in developing standards for existing HWC sources is to determine a MACT floor emission level, the minimum level at which the standard can be set. This was done separately for each of the three source categories covered by the HWC rulemaking. To identify the floor level, the Agency first identified the emission controls used by sources with emissions

levels at or below the level emitted by the median of the best performing 12 percent of sources or best 5 performing sources (depending on the number of sources in the source category or subcategory). These best performing sources are called the MACT pool and the emission controls they use are called MACT floor controls.

The Agency then identified an emissions level that properly designed and operated MACT floor controls are consistently achieving at existing HWCs in each separate source category. This is called the floor emission level. To ensure that the floor level is being achieved by all sources using floor controls (i.e., not just the MACT pool sources), we generally considered emissions data from all sources (in a source category) that use MACT floor controls. The data set of all sources using floor controls is called the expanded MACT pool. Using the expanded MACT pool, the floor level is generally established as the level achieved by the source with the highest emissions average. EPA has used this same methodology in a number of MACT standards, i.e., secondary lead smelters, medical waste incinerators, proposed non-hazardous waste burning cement kilns, although it has been challenged as insufficiently stringent by a number of environmental groups.

The Agency is establishing a MACT standard for semivolatile metals (SVM), comprised of combined emissions of lead and cadmium, for each separate source category. Historically, our data indicate that these HAPs have been controlled, at least in part, by feedrate control of the metal in the hazardous waste (HW). In addition to HW feedrate control, SVM also are controlled by particulate matter emissions control equipment (i.e., because SVM is in particulate form in stack emissions). Therefore, we believe feedrate control is a control option that must be considered as a basis for determining the floor. (See enclosure B.)

EPA is considering using a data analysis method called the Aggregate Feedrate MTEC (AFM) approach to establish floor controls and emission levels for SVMs in the final rule. The AFM procedure focuses only on the hazardous waste feed.[1] First, the sources using the best performing MACT floor emission controls are identified.[2] (That is, the sources with MACT air pollution control devices (APCD) for PM that also are feeding hazardous wastes with the lowest total concentration of chlorine plus metal HAPs.) From these sources, the MACT feedrates for mercury, SVM, LVM, and total chlorine are identified. Finally, from these feedrates, the Agency identifies the associated HAP emissions floor level. This is based on the emissions from all facilities achieving the feedrate while using the MACT APCD.

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[1] As discussed at proposal, the feedrates are expressed as HW MTECs (maximum theoretical emission concentrations). MTEC is an approach to normalize feedrates across sources with varying sizes (e.g., feedrate capacities, gas flowrates). It is calculated by dividing the feedrate by the gas flow rate, and is expressed as μg/dscm.

[2] This applies both where the HAP is controlled by an APCD and feedrate control (e.g., for SVM) and where the HAP is controlled solely by feedrate control (e.g., mercury for cement kilns).

Enclosure B

Rationale for Using Hazardous Waste Feedrate Control as MACT Floor Control

EPA has concluded that hazardous waste incinerators, hazardous waste burning cement kilns, and hazardous waste burning light-weight aggregate kilns are today controlling SVM emissions, at least partially, through hazardous waste feedrate control. The Agency believes this existing control provides an acceptable basis upon which to determine MACT floor levels for the following reasons. First, Section 112(d)(2)(A) of the Clean Air Act states that materials substitution (e.g., feedrate control of hazardous waste) is a type of control technology which can be MACT, so that EPA is required to consider this technology as part of the MACT process. Second, hazardous waste combustion facilities are presently controlling the level of metal HAPs in the hazardous waste they combust because they are required to do so by regulation or through permit conditions. For example, the RCRA Boiler and Industrial Furnace (BIF) regulations require the control of metals and chlorine levels in hazardous waste feed[1]. The fact that these existing controls are risk-based, rather than technology-based, does not mean that they are not a means of controlling air emissions. Floor standards are to be based on "emission limitation[s]" achieved by the best existing sources. An "emission limitation" includes "a requirement established by the ... Administrator which limits the quantity, rate, or concentration of emissions.... including any requirement relating to the operation... of a source...." (see CAA section 302 (k)). The BIF rules consequently establish an "emissions limit," as do hazardous waste incinerator permit standards. Accordingly, OSWER is recommending that HW feedrate be used, entirely or partially, to determine floor levels and beyond-the-floor levels for SVM.

At proposal, the Agency used hazardous waste (HW) feedrates as part of the technology basis for the proposed floor emission levels.[2] MACT MTECs were established individually for Hg, SVM, LVM, and total chlorine at a level equal to the highest MTEC of the best performing 6 percent of sources.[3] For some HAPs, HW feedrate control of metals and chlorine was the sole component of floor control (i.e., where the best performing existing sources do not use pollution

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1 Floors in the HWC MACT rule will not be based at the levels specified by the BIF rule, but rather by levels reflecting sources' actual practices and emissions.

2 See 61 FR at 17366.

3 The aggregate MTEC approach anticipated for the final rule is different from the individual MTEC approach used at proposal in that it better ensures achievability by, and is more representative of, hazardous waste fed in practice. Under the individual MTEC approach, few if any sources may have been feeding a hazardous waste that contained all the lowest levels of each metal and chlorine identified individually.

control equipment designed to remove the HAP). Examples include mercury and total chlorine from cement kilns. For other HAPs, HW feedrate control of metals and chlorine was identified as a partial component of MACT floor control (e.g., floor control for SVMs include good PM control in addition to feedrate control of SVMs in HW).

In the May 1997 NODA, the Agency continued to consider HW feedrate control of metals and chlorine as a valid floor control technology. However, rather than defining a specific MACT control feedrate level, the Agency instead relied on another analysis tool, an emissions breakpoint analysis, to identify sources feeding metals and/or chlorine at unusually high (and not MACT) levels. The Agency at that time believed that the breakpoint analysis was a less problematic approach to identify sources using MACT floor control than the approaches proposed initially.

Given commentors' concerns with the Agency's emissions breakpoint analysis, however, the Agency has concluded that specifying MTECs as MACT control (as partial or sole control, as appropriate) will be necessary to effectively capture the feedrate component of MACT control. As discussed above, the Office of Solid Waste and Emergency Response recommends identifying MACT MTECs for the final rule using the aggregate hazardous waste feedrate MTEC approach rather than the April 1996 proposed approach of identifying MACT feedrate control for each HAP or HAP group individually.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

APR 16 1999

OFFICE OF
SOLID WASTE AND EMERGENCY
RESPONSE

The Honorable James M. Inhofe
United States Senate
Washington, DC 20510

Dear Senator Inhofe:

Thank you for your letter of February 11, 1999, co-signed by Senator Wyden, regarding the Agency's rulemaking to develop Maximum Achievable Control Technology for hazardous waste combustors (HWC MACT rule). Your letter poses several specific questions about the rulemaking and our internal workgroup process for development of final emissions standards for semivolatile metals (lead and cadmium) for hazardous waste burning cement kilns.

At this time, the HWC MACT rulemaking is still in the deliberative phase. The final rulemaking package has been drafted and is undergoing a three-month review by the Office of Management and Budget prior to signature by the Administrator. Because the rule is at a sensitive stage in its development, we are able to provide only a partial response to your questions. In addition, because the rule is still under review, the responses provided should not be viewed as final Agency action or final policy determinations.

Your letter requested information from the HWC MACT rulemaking record establishing a correlation between semivolatile metal (SVM) feedrates and air emissions of SVMs from HWC cement kilns. Our response to these questions (Question 1) is contained in Attachments A and B and the enclosed supporting documents.

You further requested that the Agency provide information supporting the rationale for the SVM emission standard in the draft final rule. In particular, you asked us to provide you with information on the approximate range of the SVM emissions standard in the draft final rule and on any disagreements or "nonconcurrences" between EPA's Office of Air and Radiation and EPA's Office of Solid Waste and Emergency Response pertaining to the SVM standard for cement kilns. The response to these requests would reveal privileged Agency deliberations and provisional rulemaking determinations that are not yet final. It is the Agency's policy not to reveal the specific contents of rulemakings prior to release of the final rule, unless this information is requested as part of a formal oversight inquiry by a Congressional committee of jurisdiction. Therefore, at this time we are unable to provide the information requested in Question 2 of your letter.

Thank you for your interest in the HWC MACT rule. If additional information is required or questions arise, please have your staff contact George Hull in our Office of Congressional and Legislative Affairs at (202) 260-7808.

Sincerely,

Timothy Fields, Jr.
Acting Assistant Administrator

Responses to May 6, 1999 Questions to Timothy Fields, Jr.
from Senator Inhofe

Regarding the HWC MACT Standards

1(a). In the latest letter Senator Wyden and I sent you on the hazardous waste combustion MACT Standard, we asked if you had data on cement kilns and feed rates. Your response again refers us to data from a single experimental incinerator. Does the Agency have any data on cement kilns and feed rates, not incinerators, and was this data used in the rulemaking process?

Response: The data we provided (cement kiln emissions and feedrate data for the semi-volatile metals (SVM), i.e., lead and cadmium) were used in the rulemaking process to confirm our engineering judgment that there is a positive relationship between metals feedrate and metals emissions. Our judgement is based, in part, on the fact that metals are not destroyed by combustion in a cement kiln and that they do not partition solely to the cement or cement kiln dust based on studies we reported to Congress in 1994. Therefore, we concluded that metal emissions must increase as metal feedrates increase. I have attached the "Draft Technical Support Document for HWC MACT Standards (NODA): Volume III: Evaluation of Metal Emissions Database to Investigate Extrapolation and Interpolation Issues, April 1997." In this document, Figures 15-20, 22a, 22b, and 27 all contain SVM metals emissions and feedrate relationship data.

We highlighted the information on this one specific incinerator in our response because this is the only data we have from a facility specifically attempting to document the relationship between metals feedrate and emissions. This positive relationship also holds true for data we have from some cement kilns (see relationship in Figure 15 and general increase in emissions with feedrate in Figures 17, 22a, and 22b for cement kilns).

1(b). If you do not have separate data on cement kilns, then please explain how the incinerator data was used for the cement kiln standards considering the Agency felt the differences between the two categories was great enough to warrant separating cement kilns and incinerators into two separate categories.

Response: The incinerator data can be used to determine the positive relationship between emissions and feedrate for all types of combustors because the relationship between metals emissions and feedrate is the same for all types of combustion systems. To determine the relationship between metals feedrate and emission rate, we evaluated the theoretical potential for emissions and the empirical data in the HWC database. We concluded that there must be some type of direct, positive relationship between metals feedrate and emissions. Metals cannot be destroyed in the combustion process, and assuming the system must reach some type of equilibrium, metals cannot accumulate in the system without reaching a saturation limit. Additionally, the theory predicts that the relationship will be proportional over a large range of feedrates (an increase in feedrate produces a consistent incremental increase in emissions). A flat

or negative relationship (that emissions decrease as feed increases) is not physically possible. Although there are some additional data that would support this, we could not be sure that the additional data had been obtained under sufficiently controlled conditions that are required for the purpose of demonstrating the relationship. Therefore, we concluded that the available data for an individual combustor confirms a positive relationship between SVM feedrate and emissions.

In 1992, the Agency established separate source categories for Portland cement manufacturing and hazardous waste incineration as major emitters of hazardous air pollutants. These sources have fundamental differences in design and operation that can affect the types and concentrations of some hazardous air pollutants and control measures. For example, Portland cement kilns have much higher emissions of organic HAPs that are attributable to desorption from raw material than hazardous waste incinerators. Further, although controlling the feedrate of metals and chlorine is a practicable control measure for hazardous waste incinerators, existing Portland cement kilns cannot practicably control the feedrate of metals and chlorine in raw materials. (Hazardous waste fuel metal content is controllable.)

2. In our latest letter, we also asked you for materials on the technical objections the Air office might have raised to your approach. You refused to produce the material claiming it is "deliberative". Because this MACT standard is different from all previous MACT standards which have been issued by the Office of Air and Radiation, *it is important for the* Committee to understand the rationale used to develop this standard, in particular the rationale differences between this standard and the other MACT standards. Unless the Administration is claiming "executive privilege" please provide the Committee with any documents involving disagreements or "nonconcurrences" between EPA's Office of Air and Radiation and EPA's Office of Solid Waste and Emergency Response pertaining to the SVM standard for cement kilns.

Response: The requested documents are attached. These documents represent predecisional discussions, often at the staff level, and contain the normal give and take of technical and scientific debate. Ultimately, all of the staff reached a consensus regarding the approach contained in our current draft of the final rule, and the Office of Air and Radiation concurred on the rule.

We believe it would be extremely harmful to the Agency if these materials were released to the public by the Committee. It would chill future legitimate scientific and policy debate within the Agency, could suggest that final decisions have been made when the decision process is not complete, and dramatically and unnecessarily increase our workload (by generating questions from the public regarding the content of these documents that will be answered in our final rule and docket). It would be particularly unfortunate to create this distraction for the Agency at a time when we must focus on completing a rule that already has taken well beyond the date that we promised in order to settle litigation on this subject.

3. Please explain why the Office of Solid Waste and Emergency Response has had the lead responsibility for the HWC MACT standard instead of the Office of Air and Radiation. In particular please explain why your Office had the lead for this standard and not the MACT standards for municipal solid waste or the medical incinerators.

Response: OSWER has had the responsibility under RCRA for emissions from incineration of hazardous waste for over twenty years and has thereby developed specialized scientific and technical expertise. Under Section 3004 (n) and (q) of the 1984 amendments to RCRA, the EPA was assigned the direct responsibility to establish air emission standards for hazardous waste incinerators and kilns burning hazardous waste as fuel. General authority to address emissions from hazardous waste incinerators has existed in RCRA since 1976. OSWER, as the EPA office charged with implementing these requirements, issued its first regulation for incinerators in 1981. Therefore, given OSWER's historical role in writing air emission standards for these types of facilities it was logical that OSWER would take the lead responsibility for the HWC MACT standards. The Office of Air and Radiation (OAR) agreed to support OSWER in the development of the CAA MACT standards in two ways -- generally applicable engineering principles applicable to combustion and air pollution control devices, if and when appropriate, and also with respect to the procedures used to determine MACT floors and beyond the floors.

For municipal solid waste incinerators and medical incinerators, OSWER has no expertise in regulating air emissions from these sources and OAR has that type of previous experience in assessing control options for these source categories, therefore, the Agency has used OAR to develop the MACT standards for this class of units. Each of these decisions is weighed with respect to experience, current workload, and other administrative factors to make sure that the Agency's resources are deployed in a reasonable and effective manner.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

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JUN - 7 1999

OFFICE OF
SOLID WASTE AND EMERGENCY
RESPONSE

The Honorable Kay Bailey Hutchison
United States Senate
Washington, D.C. 20510

Dear Senator Hutchison:

This is in response to your April 15, 1999 letter to Administrator Carol Browner regarding our Maximum Achievable Control Technology (MACT) standards for cement kilns that burn hazardous waste fuels. You expressed concern that beyond-the-floor standards may not reduce risks and may reduce beneficial use of hazardous waste as fuel. Specifically, you ask whether we have data demonstrating that the beyond-the-floor standard will reduce risk and whether the reduced beneficial use of hazardous waste as fuel may outstrip the risk reduction. Finally, you ask whether beyond-the-floor standards are consistent with the Administrator's statement before your Committee that the Agency intends to develop tools and data that will move the air toxics program from an almost exclusively technology-based program to a risk-based program.

As you may be aware, we are evaluating a beyond-the-floor standard for combined lead and cadmium emissions from cement kilns. The emission level being achieved by the average of the best performing 12 percent of cement kilns--the floor level--is 650 μg/dscm. We are evaluating a beyond-the-floor emission level of 240 μg/dscm based on control of the feedrate to the kiln of lead and cadmium in hazardous waste. It is in this context that I address each of your concerns about this beyond-the-floor standard.

Would a Beyond-the Floor Lead and Cadmium Standard Reduce Risk?

A beyond-the-floor standard for lead and cadmium would reduce emissions of these metals by 5.5 megagrams per year beyond the reductions that would be provided by the floor emission level. This represents an additional 54 percent reduction in lead and cadmium emissions from the floor levels. Approximately 90 percent of these reductions are attributable to lead emissions. We consider this magnitude of additional lead reduction to be a very important element of our overarching concern for the health of American children, which underlies EPA's Children's Health Initiative. As you are aware, lead emissions are of the highest significance to children's health. If a pregnant woman is exposed to lead before or during her pregnancy, it can be carried to the unborn child and cause premature birth, low birth weight, or even abortion. For

infants or young children, lead exposure has been shown to decrease intelligence (IQ) scores, slow their growth, and cause hearing problems. We are therefore committed to reducing lead emissions wherever feasible.

With respect to risks at the floor and beyond the floor levels, it is very important to understand at the outset that toxicity data for lead do not exhibit a clear threshold of response. Evidence of neurotoxic and behavioral effects occur at levels so low as to be essentially without a threshold. Therefore, even very low levels of exposure to lead carries some risk to young children, who are the most sensitive to its effects. Our risk analysis indicates that there will be a small reduction in blood lead levels in children with a beyond-the-floor lead standard. Although we do not project a reduction in the numbers of children with blood lead levels that exceed the Centers for Disease Control and Prevention intervention level for initiating community lead prevention efforts (i.e., 10 micrograms lead per deciliter blood), our analysis does not address risks to children of minorities. These children are at higher risk because their blood lead levels are higher than other children's and, therefore, are most likely to benefit from even a small reduction in lead exposures. As mentioned above, we intend to go beyond the floor as part of our overall policy commitment to protect our children from the detrimental effects of lead wherever feasible.

Would a Beyond-the-Floor Lead and Cadmium Standard Result in Less Beneficial Use of Hazardous Waste As Fuel?

We do not believe a beyond-the-floor standard for lead and cadmium would affect the quantity of hazardous waste fuels burned in cement kilns. Our economic impacts analysis currently indicates that no additional cement facilities would stop burning hazardous waste if a beyond-the-floor standard were established for lead and cadmium rather than a floor standard. We project that one or two of 18 cement facilities may stop burning hazardous waste even if only the floor standard for lead and cadmium were adopted. If these cement facilities do actually stop burning hazardous waste, we predict that the hazardous waste fuel will be burned by other cement facilities or hazardous waste incinerators. This is because our data indicate that hazardous waste cement kilns and commercial incinerators are currently burning at levels significantly below their maximum practical capacity. Thus, we do not predict any less use of hazardous waste as fuel as a result of the beyond-the-floor standard for lead and cadmium.

Would a Decision to Promulgate a Beyond-the-Floor Lead and Cadmium Standard Be Consistent with the Administrator's Statement Before Your Subcommittee?

In February 24, 1999 testimony before the Senate Environment and Public Works Committee, the Administrator said that the air toxics program will focus on urban air toxics to develop tools and data that will move the program from an almost exclusively technology-based program to a risk-based program. The Administrator was referring to our initiative to move beyond simply counting emissions reductions under the air toxics program to measuring progress and establishing priorities in terms of risk reduction. This is not directly related to how the MACT standards are set in any particular rulemaking under Section 112 of the Clean Air Act. As you know, these standards are to be derived based primarily on the technological capability of various air pollution control equipment and strategies.

The Administrator's statement that we will seek to assess our progress under Section 112 [illegible] of a risk metric reflects, at least in part, our implementation of the Government [illegible] and Results Act (GPRA). Our current performance goal for the air toxics program, [illegible] not only the MACT standards, but all the statutory components of Section 112, is [illegible] of emission reductions. Because our knowledge and tools to assess the impacts of [illegible] on public health and the environment were limited when we set this current goal, it [illegible]flects the straightforward intent to reduce total air toxics emissions as a means to directly [illegible] risks associated with exposure to air toxics. However, as we extend our knowledge, [illegible]lop better assessment tools, and begin to implement the risk-based statutory requirements [illegible]der Section 112, we intend to modify our goal to one directed specifically at risk reductions associated with exposure to air toxics. We will then use our risk-based knowledge and tools to [illegible] progress in meeting our goals and to establish priorities for implementing various components of our air toxics program.

In developing MACT standards, however, we will continue to comply with the statutory [illegible]date to establish standards that require the maximum degree of reduction in emissions of [illegible] pollutants that are achievable taking into account the cost of achieving the [illegible] any nonair quality health and environmental impacts and energy requirements. [illegible] standards are a critical component of the overall air toxics program described in the [illegible]ator's testimony.

I hope this addresses your concerns. If you have additional questions regarding the [illegible]Rulemaking, please have your staff contact David Hockey, Project Director, at 703-308-[illegible].

Sincerely yours,

Matt Hale

Elizabeth A. Cotsworth, Acting Director
Office of Solid Waste

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JUL 30 1999

OFFICE OF
SOLID WASTE AND EMERGENCY
RESPONSE

Honorable James M. Inhofe
United States Senate
Washington, D.C. 20510

Dear Senator Inhofe:

Thank you for your letter of July 23, 1999, to Administrator Browner requesting that the Environmental Protection Agency (EPA or Agency) reconsider the appropriateness of the air emission regulation for hazardous waste combustors (HWCs), scheduled for promulgation in the very near future. Your correspondence indicates concern that we have chosen to require "beyond-the-floor" (BTF) maximum achievable control (MACT) standards under the Clean Air Act (CAA) without demonstrating sufficient benefits to justify the action. You also state that a significant inequity exists in distribution of compliance cost burdens among the various subcategories as related to emission reductions, and that this result cannot be justified under the CAA. You urge the Agency to carefully review the rule to determine if it is actually ready for publication.

Let me first address your concern about our decision to adopt several BTF standards. For existing facilities, the statute requires that the Agency develop technology-based "floor" standards representative of the average emissions being achieved by the best performing 12% of facilities in a particular source category. The statute then mandates that we pursue more stringent BTF standards taking into account (among other things) the cost of emission reductions. Across a total of 24 standards for the three source categories, we have determined that five BTF standards are warranted. These standards provide either additional control of pollutants of major significance to human health (dioxins, furans, cadmium and lead) or provide additional control of listed hazardous air pollutants at very little incremental cost (chlorine and hydrochloric acid).

With respect to your second point about significant inequities in the distribution of compliance costs burdens, we believe that we have followed the statutory approach. We do not believe the CAA directs EPA to "balance" the impact of the regulation equally among different source categories or within a source category. By mandating that MACT rules reflect, at a minimum, emission levels being achieved by the average of the "best performing 12 percent" of facilities within a source category, the CAA contemplates that poorer-performing facilities will have to bear more costs to come into compliance with MACT standards. A large percentage of the cost of compliance with the regulations may result simply from having to achieve the basic "floor" levels of control, where cost is not a factor in determining the standard. This appears to be the case in the hazardous waste combustor rule.

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Appropriate Average Cost Effectiveness criteria

Background.

When the department assumed the PSD program in 1987 an average cost effectiveness criteria of $3,000-3,500 evolved. This was based on staff discussions with other states and with EPA staff as well as reflecting the Benzene NESHAP rulemaking which used an economic cost effectiveness of ~$3,000/ton. These criteria firmed up as more staff were brought into the PSD program and with the 1991 training based on EPA's 1990 Draft Manual. A major review of the average cost criteria was conducted during the 1993 ADM permit review. This 1992 analysis was limited by the comments to a review of whether-or-not the existing criteria was excessive. This review affirmed that the $3,000-3,500 range was not too stringent.

Available data.

There are two approaches to reviewing the appropriateness of a specific cost criteria:

1. The first is to update existing criteria considering the changes in the economy (such as inflation factors, cost changes, etc.) assuming that the policy considerations that lead to the original criteria are still valid;
2. The second is to review the criteria currently in use by other practitioners to identify not only changes in economic conditions but also changes in societal expectations. Potential practitioners include other states and EPA. EPA actions can include rulemaking efforts as well as manual and guidance documents. EPA has two types of rulemaking actions which are relevant: New Source Performance Standards and National Emission Standards for Hazardous Air Pollutants.

1. Changes in the Economy

There are several indexes maintained by various organizations that track changes in costs. They range from the general Consumer Price Index to specific Chemical Manufacturing Indexes or Building Cost Indexes for specific geographical areas or industries. Even though these specific indexes have significant year-to-year differences (as they follow price changes in specific components) over time they all appear to follow quite closely the general Consumer Price Index. For this review the Consumer Price Index was used since this is also the best known and most readily accessible statistic.

2. Other Practitioners

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Over the years department staff have surveyed other states to try to determine what criteria are in use in other PSD programs. Major Departmental surveys were conducted in 1993 and 1997. In addition the Iowa Department of Economic Development conducted a broad survey of air program activities for the department in early 1998 which included BACT cost information. Throughout these surveys there have been significant difficulties in developing confident figures because of the different answers given by different staff within the same program. There are three identified causes of uncertainty in these surveys. Part of this is due to the degree of familiarity that the individual has with the program. In some cases individuals who are assumed to be knowledgeable turn out to have incomplete information. On some cases the individual responding with the latest, or lowest, or highest permit action completed versus what measure they would use with the next application that come to them. Finally, some individuals have indicated average costs limits based on determinations made based on other considerations (including political necessities) that simply made the cost considerations irrelevant. Finally, many (if not most) states adjust their criteria over time reflecting higher acceptable costs. While staff try to identify these factors during the survey, they are common enough to add uncertainty to all the data collected regarding other state's actions.

EPA has provided some (but limited) guidance in the form of instructional material or guidance documents. The single document most often referred to is the 1990 Draft New Source Review Workshop Manual.

EPA New Source Performance Standards (NSPS), when adopted, are the least aggressive control options that may be considered for PSD determinations for that industry. Since they are also the least cost effective options available they define the lowest acceptable average cost effectiveness ($/Ton) that can considered. Unfortunately these rulemaking efforts do not identify what a maximum acceptable cost would be. Rather, they only identify the cost of the option selected. The only certainty is that the limit is higher than the selected option. There is also a dramatic increase in acceptable costs over the past ten years so that it is very important to assess the timeliness of the EPA action. Here also it is important to review the basis for the determination with some NSPS rulemaking based on technology limitations rather than cost considerations. To some degree the cost increases reflect inflation but they are so dramatically greater that they must reflect social changes in acceptable costs.

With the 1990 Amendments to the federal Clean Air Act, hazardous air pollutants were removed from PSD review based on to the National Emission Standards for Hazardous Air Pollutants (NESHAP) program which effectively replaced the BACT determination with a Maximum Available Control Technology (MACT) determination during rulemaking. As such these determinations serve and an

indicator of what would have been an acceptable BACT cost. Here as with state surveys it is important to evaluate the basis of the action. Several MACT determinations have been based on the minimally acceptable demonstrated level of control in the industry involved (the "MACT floor") rather than the costs identified with that option. These determinations show very low costs (and, sometimes, cost savings). Finally, there has also been dramatic increases in acceptable costs over time.

Additional insight can be gained by looking at RACT (Reasonably Available Control Technology) and LAER (Lowest Achievable Emission Reduction) determinations. RACT is a less rigorous standard than BACT that identifies controls that should be implemented on all sources regardless of size and without further analysis where-ever that pollutant is a concern LAER is a more rigorous standard that is applied to major sources (roughly equivalent to PSD sources though in severe enough non-attainment areas sources emitting as little as 10 tons per year may be subject to LAER.) that are in areas already violating public health standards (non-attainment areas) so that any controls that could work at that site should be implemented with little or no consideration of costs. In general a lower economic burden would be expected for RACT controls while a higher economic burden would be expected of LAER controls.

Results

Changes In the Economy

Changes in the Consumer Price index since the Department assumed the PSD program indicated inflation of 42.5% over that period.(March 1998 CPI of 162.2, July 1987 CPI of 113.8) (This trend over time is shown in Figure 2 Figure 2 also includes the Building Cost Index for Kansas City for 1971 through 1991 in order to identify any dramatic differences in the indexes. Adjusting the average costs effectiveness criteria to reflect constant dollars would suggest that the current limit should be approximately $5,000/ton ($4,989/ton).

Surveys of air programs in other states.

The 1993 IDNR survey of nine other mid-western state regulatory agencies showed recent PSD permits in which the required controls had costs of: NOx of $600/ton,NOx of $3,300/ton,NOx of $7,200/ton,SO2 of $1,700/ton, and NOx of $2,200/ton.

The average $/ton for these finalized BACTs was $3,000/ton. [Adjusting for inflation since 1993 would suggest a current average of $3,367 (1993 CPI of 144.5) with a high of $8,081 and a low of $673.]

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When asked about cost cut-offs, three states indicated that they did not use a specific limit while others indicated guideline of $2,000/ton maximum "unofficial" cutoff of $5,000/ton,$7,000/ton,$6,500/ton, and $4,000/ton as "automatic".

A more recent (summer 1997) DNR survey of other states suggests that the average cost effectiveness criteria should be in the $5,000 and $7,000/ton range. There was notable uniformity among border states (Illinois: $5,000-$8,000/ton, Minnesota: $6,000/ton, Missouri: $5,000/ton starting point, Wisconsin: $5,000-$7,000/ton).

The extreme among state agencies is the California Air Resources Board (CARB). In a February 1997.determination, the CARB found a cost of $1.16/pound ($23,200/ton) to be cost effective while a cost of $4.50/pound ($90,000/ton) was found to be excessive. In a December, 1997 proposal CARB determined that cost from $470/ton to as high as $20,000/ton were reasonable for nitrogen oxides (NOx) RACT controls. In the same action, a cost effectiveness threshold of $12/pound ($24,000/ton) was noted for BARCT[3] (Best Available Retrofit Control Technology) determination by) for NOx and controls with cost from $2,000/ton up to $28,000/ton were found to be acceptable.

The Iowa Department of Economic Development (IDED) also performed a survey for the DNR in the spring 1998 dealing with many aspects of state air programs including BACT cost criteria.

Of the seven states in the IDED survey, one (Wisconsin) noted a $6,000/ ton criteria for all pollutants evaluated on a "case-by-case" basis with the further note that "Wisconsin looks at other industry sources to see if any facility has installed BACT." One (Pennsylvania) stated that "no formal figures (were) established" but went on to note a range of $500 to $10,000/ton for VOCs. Another (Texas) noted that it used a criteria but that it " used unpublished dollars per ton figures in the evaluation of BACT since these figures can vary based on the source type, even for the same contaminant. This allows the NSRP technical staff maximum flexibility to evaluate BACT options on a case-by-case basis." Missouri noted a criteria of $5,000/ton for all pollutants with the qualifier that "these are guidelines NOT absolute values" and the further explanation that "the state does not have a specific cost per ton that it uses during PSD review, however, the estimated cost is taken into consideration during permit review. Illinois noted that "We evaluate feasible cost case-by-case". While Ohio noted, "No set value. Evaluated case-

[3] The California Air Resources Board Rules define (BARCT) as "an emission limitation that is based on the maximum degree of reduction achievable, taking into account environmental, energy, and economic impacts by each class of category of source." California Health and Safety Code, section 40406. This is slightly different that the federal BACT definition though it retains the "maximum degree of reduction"..." achievable" for such "source" and "taking into account environmental, energy, and economic impacts".

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by-case." And Follows USEPA guidance." Finally, Louisiana indicated that they do not used economic feasibility with no further explanation.

Noteworthy in the IDED survey is that the Wisconsin and Missouri responses agree with the responses that IDNR has previously obtained. By contrast Illinois' response to IDED differed from the response to IDNR and all states placed emphasis on the case-by-case nature of PSD review.

EPA Actions

The 1990 draft EPA New Source Review Workshop Manual does not indicate what criteria to use. It does describe the procedure to be used and illustrates that with a simple example problem. In that manual that example problem 1rejected a control option with a calculated average cost effectiveness of $6,600/ton in favor of an option with a average cost effectiveness of $2,470/ton. Confusing this determination, however, was that the rejected option also had an incremental cost 9X the average cost. Adjusting for inflation since 1990 leads to a 1998 limit of somewhere below $8,1291ton(162.2/130.7*6600) yet somewhere above $3,065/ton.

EPA NSPS rulemaking in the late 80's had cost in the $1,000-$2,500/ton range suggesting a BACT limit somewhat higher. This is consistent with the department's limit at that time. In the ten years since, acceptable costs have been increasing with more recent rulemaking has indicated that costs of $6,075/ton were acceptable. This suggests that the acceptable cost limit should be somewhat higher.

EPA MACT analysis

In cases where the cost effectiveness of the regulation was a determinant, the various EPA MACT rulemaking actions identified acceptable average costs ranging from $5,335/ton to $14,200/ton. The average of the acceptable average costs of these various rulemaking efforts was $8,524/ton. The 1996 determinations have been in the $9,500-$10,500/ton range while the first several determinations (1994-5) were in the $5,300-$14,200/ton range. More recent (1998) action in proposing MACT standards for the portland cement manufacturing industry estimates acceptable control strategies for existing facilities that would cost about $7,100/ton of particulate matter controlled to over $400,000/ton of HAP controlled. The cost of rejected control alternatives was not discussed.

EPA RACT analysis

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With the 1990 Clean Air Act, additional efforts were required to correct the many ozone non-attainment areas across the country. To implement these new controls EPA reassessed RACT requirements for NOx (nitrogen oxides) control. In a 1994 summary memo, EPA noted that the type of emission controls that would be required for RACT ranged from $160 to $5,200 per ton of emissions reduced while most facilities would be able to get the required 30% to 50% reduction in NOx emission with controls would fall into the $160/ton to $1300/ton range. EPA went on to note that more expensive controls would be considered to meet that 30% to 50% emission reduction requirement. In a May 13, 1998 federal register adoption of site specific RACT limits for several sources in New Hampshire, EPA agreed that emission control that would cost $4,700/ton and $8,800/ton were not required to meet RACT given the (less restrictive) emission reductions required by New Hampshire. In this rule making EPA noted that this was consistent with other site specific RACT determinations approved by EPA.

Conclusions

Adjusting the average costs effectiveness criteria to reflect constant dollars would suggest that the current limit should be approximately $5,000/ton ($4,942/ton).

The state surveys suggests that the appropriate average cost effectiveness should be updated to $5,000/ton to $8,000/ton range.

EPA rulemaking suggests that the average costs effectiveness criteria should be at least $6,000/ton and possibly $10,000/ton.

Taken together, the data suggests that the appropriate average cost effectiveness criteria should be updated to $7,000/ton or $8,000/ton.

The MINIMUM average cost effectiveness criteria that could be justified for use in use for PSD permitting by Iowa DNR is $5,000/ton. This would have to be based soley on the impacts of inflation without reflecting the apparent changes in societal expectations.

Appropriate Incremental Costs criteria

Background

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Incremental cost effectiveness analysis is used to evaluate the relative desirability of two control options in those cases where a relatively large investment is needed to affect a relatively small improvement in control efficiency.

There was extensive discussion of the use of incremental cost effectiveness analysis during the PSD permitting of ADM's Boiler #4 in Cedar Rapids. During this discussion ADM brought in several recognized experts in PSD BACT procedures. As a result of this discussion the department agreed that incremental cost effectiveness analyses should be used whenever a control strategy's average cost effectiveness approach the average cost limit. Specifically, the department agreed that incremental costs should be evaluated whenever average costs exceeded 75% of the average cost effectiveness limit. Furthermore the department agreed that the incremental cost effectiveness limit should be approximately 7X the average cost limit.

There is little information that can be relied on from discussions from other states, from EPA rulemaking or from EPA instructional material because incremental cost effectiveness is so seldom the decision point. In some cases analysis refer to incremental analyses over some baseline condition but this is really an average costs analysis. The only instructional information available is from the 1990 draft New Source Review Workshop Manual in which an example is presented in which a higher cost control option with an incremental cost 9X the average annual cost is rejected in favor a lower average cost option with and incremental cost 3X the annual average cost. This information was taken into account during the ADM Boiler #4 analysis.

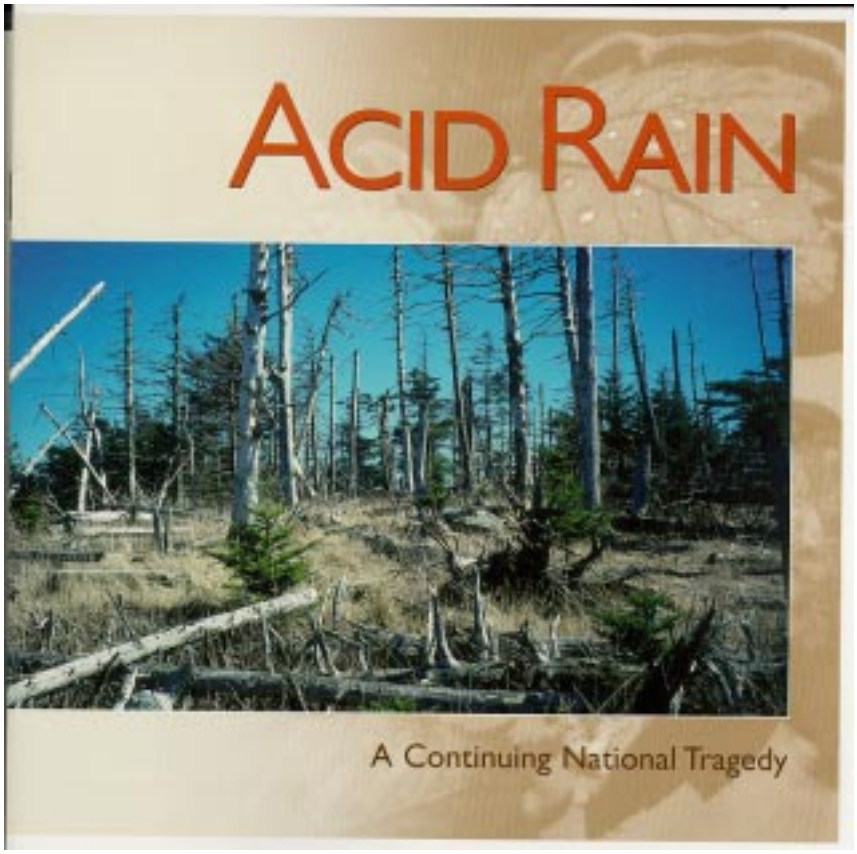
Conclusions

There is nothing that has come to the department's attention to suggest any change in the determination made during the ADM permitting.

A $7,000/ton average costs criteria would suggest a $50,000/ton incremental cost criteria.

A $8,000/ton average costs criteria would suggest a $56,000/ton incremental cost criteria.

Appropriate minimally acceptable quality or cost estimates


ACID RAIN
A Continuing National Tragedy

"We still have a very major problem with acid rain. That is scientific fact. In that regard, the 1990 Clean Air Act Amendments have not worked very well."

Acid rain scientist Dr. Gene Likens, Boston Globe, February 8, 1998

Despite the Clean Air Act Amendments of 1990, acid rain continues to degrade ecosystems in high-elevation forests and waters from New York's Adirondack Park, Taconic Ridge, Catskill Park and Hudson Highlands through New England's Green and White Mountains and the mid-Appalachian range in the Carolinas and Tennessee. Associated nitrogen-based air pollution is ruining aquatic habitat in Long Island Sound and the Chesapeake Bay and even Colorado's Rocky Mountains are now showing air pollution-related damage.

The Long-suffering High Country

The air pollution that causes acid rain has been falling on some areas of the United States for nearly a century. But the damage acid rain causes can take a long time to develop. In many of the most heavily damaged regions – such as the forests of New York and New England – scientists have been documenting ecological damage since the 1970s. Now other regions are discovering that their health and environment are suffering too.

In 1990, Congress amended the Clean Air Act and instructed the U.S. Environmental Protection Agency to create the nation's first acid rain control program. In 1992, the Bush Administration boasted that the new program would "end acidity in Adirondack lakes and streams." But many recognized right away that the program would be inadequate to stop the destruction in the Adirondack Park and the nation's other most sensitive ecosystems.

In 1993, the NYS Dept. of Environmental Conservation, the Natural Resources Defense Council and the Adirondack Council sued the EPA over the new program. In a partial settlement of the suit, the EPA agreed to complete a 1996 report to Congress on whether the new program would have the desired effect. The report confirmed our fears.

The EPA noted that the current federal acid rain program could only slow the rate of damage done to the Adirondack Park. More lakes would die. Meanwhile, acid rain and the air pollution that causes it are damaging other areas of the nation at an alarming rate.

Acid rain has been harming the ecosystems of the Catskill Mountains for as long as the Adirondacks. While the **Catskill Park** is one-tenth the size of the Adirondack Park and has far fewer lakes, its legendary rivers and trout streams have lost much of their vitality.

Farther south, the mid-**Appalachian Mountains** are being devastated. Spruce forests are dying, streams are losing their fish life, insect infestations in forests threaten to wipe out entire species.

EPA noted that the current federal acid rain program could only slow the rate of damage done... More lakes would die.

In New England, studies by acid rain research scientist Dr. Gene Likens showed that the hardwood forest of **New Hampshire's** Hubbard Brook area has stopped growing. Sugar maples are at particular risk — bad news indeed for furniture and syrup makers.

Up north, the Canadian government estimates that by 2010, even with full implementation of the Canadian and American acid rain programs, an area the size of France and Britain in **southern Canada** will continue to receive harmful levels of acid rain. As many as 95,000 lakes will remain damaged, they stated in 1997.

Out west, scientists in the **Rocky Mountains** are finding that power plant emissions are saturating high-elevation watersheds in Colorado with acid-causing nitrogen. Evergreen forests are losing their needles and tree health is declining throughout the Front Range.

Acid rain damage is not limited to forests and aquatic ecosystems. In Pennsylvania, the monuments at the Civil War battlefield in **Gettysburg** are deteriorating far more quickly than similar structures in places not affected by acid rain. Throughout the Northeast, stone, brick and block buildings, as well as automobile finishes, show signs of more extensive and rapid weathering than counterparts in other regions of the country.

In the **Chesapeake Bay** and **Long Island Sound**, nitrogen-based pollution is overloading the water with nutrients. This contributes to an overabundance of algae, which when they die and decay, deplete the water of precious oxygen needed by all aquatic animals. The condition is known as hypoxia.

Closer to our homes, acidity in water supplies is leaching poisonous metals such as lead into the drinking water. Copper is killing the beneficial bacteria that make septic systems function. Airborne particles of sulfur — the chief component of acid rain — also cause and worsen lung diseases.

The few fish species that can survive in acidic waters are accumulating mercury in their body tissue. Now, mammals and birds that live on those fish are showing signs of mercury contamination.

More than 500 lakes and ponds (out of 2,800) in the Adirondack Park are already too acidic to support the plants and aquatic wildlife that once existed in them. Each spring, an entire winter's acidic snowpack melts into the Park's waters, joining them with a huge pulse of acidity known as "acid shock." It could not happen at a worse time. Many of the Park's plants, animals and insects are at their most vulnerable at the beginning of the growing season.

Red spruce forests on the western-facing slopes of the Park's High Peaks region are stunted and dying at a rapid pace. Those forests receive extremely high levels of polluted precipitation that blows in from the coal-fired smokestacks of the Ohio Valley and beyond. Day after day, even when it doesn't rain or snow, the pollution hangs in acid clouds that shroud the mountains in a caustic fog.

Adding insult to a long list of injuries, Canadian studies show that the larvae of black flies — the bane of spring outdoor activities in the Northeast and southern Canada — seem to thrive in acidic waters. Consequently, their populations are exploding as pollution changes the chemistry of the waters from which they hatch.

The Adirondack Park is suffering the worst damage in the nation from acid rain. And because nearly all of the utility plant pollution that causes acid rain in the Adirondacks comes from outside the state, New Yorkers alone can do little to prevent the onslaught.

The good news is that the current acid rain program is costing utility companies far less than they predicted when Congress was contemplating the Clean Air Act Amendments of 1990. As a result, the total costs of finishing the job Congress intended to do in 1990 would still be less than original estimates.

Tightening sulfur emissions further — combined with strict, new controls on nitrogen emissions — would help restore the health of our forests, lakes and streams; help prevent certain lung diseases; increase long-range visibility, and help coastal estuaries maintain healthy levels of dissolved oxygen.

This problem can be solved before the symptoms get any worse. The solution is affordable. All that remains is for Congress to act.

See Specific Recommendations on Page 22

Low pH and species loss.

Black flies are the scourge of springtime outdoor activity in the Northeast and southern Canada. Their bites are painful bloody and often leave welts on the skin. While many aquatic species decline and even vanish when acidity increases, black fly larvae remain unaffected by acidity or the heavy metals acidity leaches into the water. As a result, the black fly has less competition for habitat and fewer predators. In short, black flies do best where acid rain is worst.

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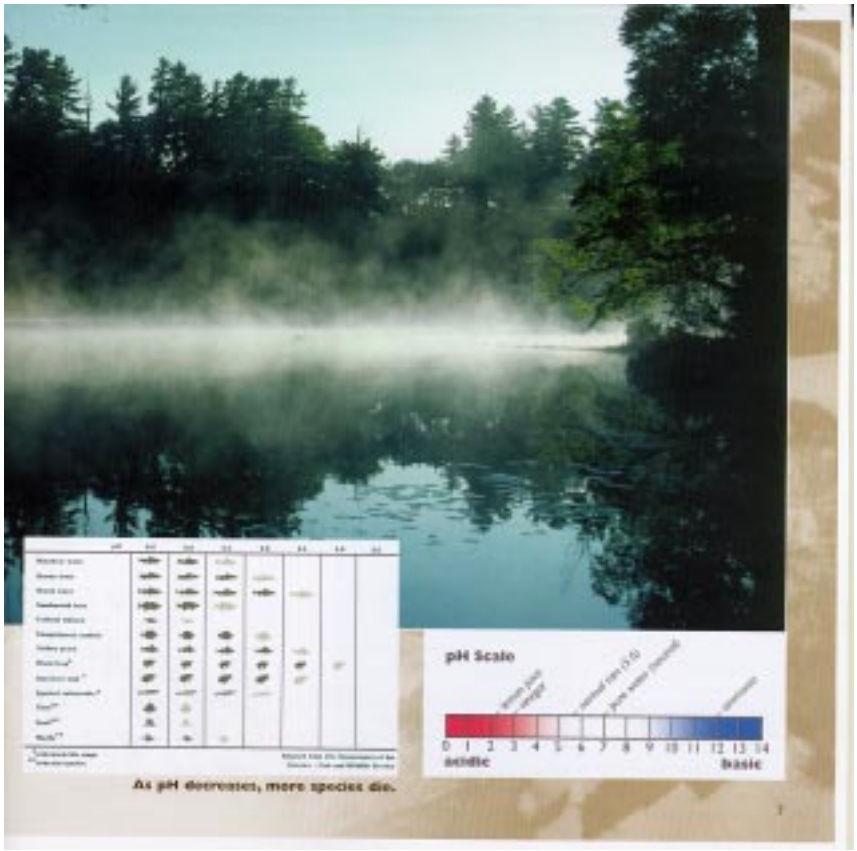
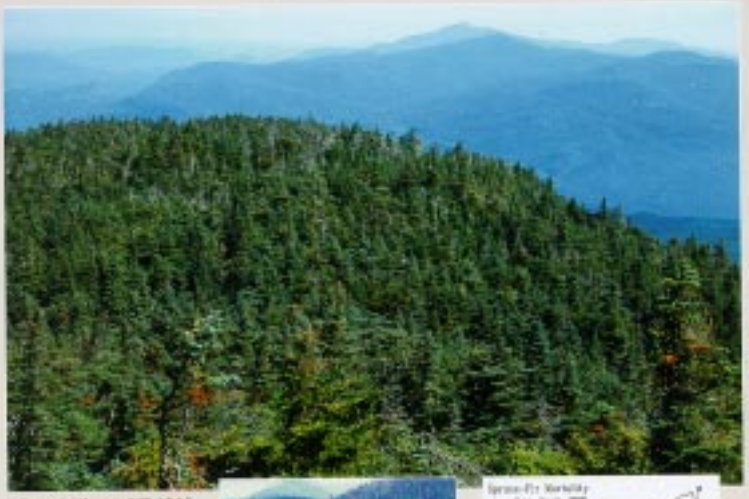
Bear Pond, NY

Black flies love acid rain.


pH Scale
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
acidic
basic
As pH decreases, more species die.



Camels Hump, VT 1963

Mount Marcy.

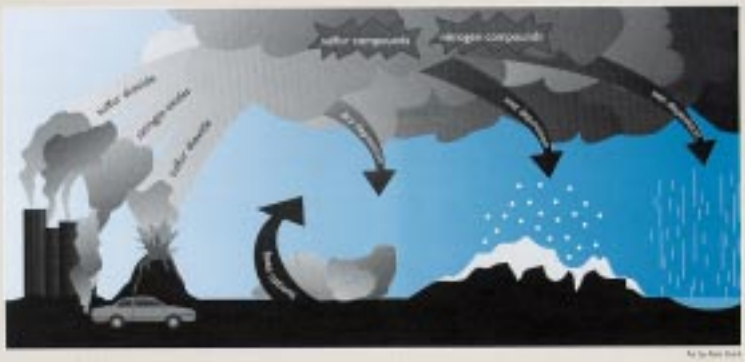
Adirondack High Peaks.

Mount Marcy, NY

Adirondack High Peaks

Camels Hump, VT 1983

Camels Hump. Camels Hump, in Vermont's Green Mountains, at left, in 1983. Above, the same location 20 years later. Photos reveal what botanical studies have confirmed: the decline in red spruce forests has been rapid and unmistakable over the past three decades. Acidity leaches aluminum out of rock and soil and depletes the soil of vital minerals. Aluminum destroys the root hairs of trees, preventing them from absorbing the water and nutrients needed for survival.



The mechanics of Acid Rain. As the above graphic shows, acid-rain-causing pollution is carried on prevailing winds and can drift for hundreds of miles before it is deposited by precipitation. Adirondack, Catskill and Appalachian mountain regions are the hardest hit because prevailing winds carry the pollution from several other states onto those mountain ranges. As the winds rise over the mountains, the moisture they contain cools and condenses into clouds, which reach the point of saturation. The resulting rain, snow, sleet and/or fog has high concentrations of sulfur and nitrogen pollution. The sulfur-dioxide becomes sulfuric acid. The nitrogen becomes nitric acid. Alkaline minerals such as calcium and magnesium in soil and the air (a.k.a. base cations) help buffer acidity. But acid rain washes those minerals out of the soil faster than weathering can replace them by breaking down rock.

Sulfur-dioxide Pollution (1998)
Nitrogen-oxide Pollution (1996)

Cranberry Lake

Stillwater Reservoir

Every single Northeastern state now has mercury-consumption warnings for fish taken from its waters.

Mercury kills. Loons require pristine shorelines and seclusion to successfully nest and breed. They find vast areas of suitable habitat within the Adirondack Park. But their habitat is shrinking in most other areas of the Northeast due to human encroachments. As a result, the loon has become a symbol of the health and solitude of the Adirondack wilderness.

Unfortunately the fish that loons eat are becoming increasingly contaminated with mercury — one of the deadliest toxic metals associated with acid rain.

Cranberry Lake and Stillwater Reservoir are two of the largest and most popular water bodies in the western Adirondack Park. They lie at the northern and southern boundaries of the Five Ponds Wilderness Area, which contains the largest contiguous virgin forest remaining in the Northeastern United States. In the mid-1990s, both lakes were found to have substantial mercury contamination. Like aluminum, mercury can be leached out of soil by acidity but it is also found in the same smokestack pollution that causes acid rain.

In 1996, something new and alarming happened. New York State officials advised women of childbearing age, the elderly and young children to avoid eating yellow perch and smallmouth bass from either lake. Both fish are less susceptible to aluminum-related gill damage than most species of trout and salmon. But that resistance allows them to live longer in acidic waters, where they slowly accumulate mercury in their fatty tissues.

The NYS Health Department has now issued similar mercury warnings for more than a dozen Adirondack lakes. Every single Northeastern state now has mercury-consumption warnings for fish taken from its waters.

The poisoning of these valuable game fish is a tragic blow to the Park's tourism industry. And the contamination is growing deadly for bird and mammal species that rely on fish for food, since the accumulated mercury in fish is transferred to whomever or whatever eats the fish.

Loon Chick Dead on Nest

Common Loon

Freshwater Damage.

Hubbard Brook, NH

Hubbard Brook. Renowned soil lab scientist Dr. Gene Likens and his colleagues at the Hubbard Brook Research Foundation reported an alarming trend in 1996. The eight-hardwood forest they studied in New Hampshire's White Mountains has essentially stopped growing. Calcium and magnesium are crucial to the growth and vitality of many tree species but are washed away from the soil by acid rain. Likens found that the amount of calcium in Hubbard Brook's soil had decreased by 58 percent since 1962, when acid rain was less severe. The weathering of rock does not replace calcium in the soil as quickly as acid rain depletes it.

As a result, the emission reductions called for in the current federal acid rain program cannot stop the damage. In addition, research suggests that some areas where acid rain has never been a problem may begin experiencing damage soon.

Rocky Mountains, CO

Rocky Mountains.

Going, Going, Gone...

White Mountain National Forest

An Adirondack Case Study. Fifty years ago, Big Moose Lake was teeming with life. For a half-century tourists flocked to the lake from near and far to escape city life and relax on the shore of a pristine lake, fifty miles from the bustle and pollution of the nearest urban center.

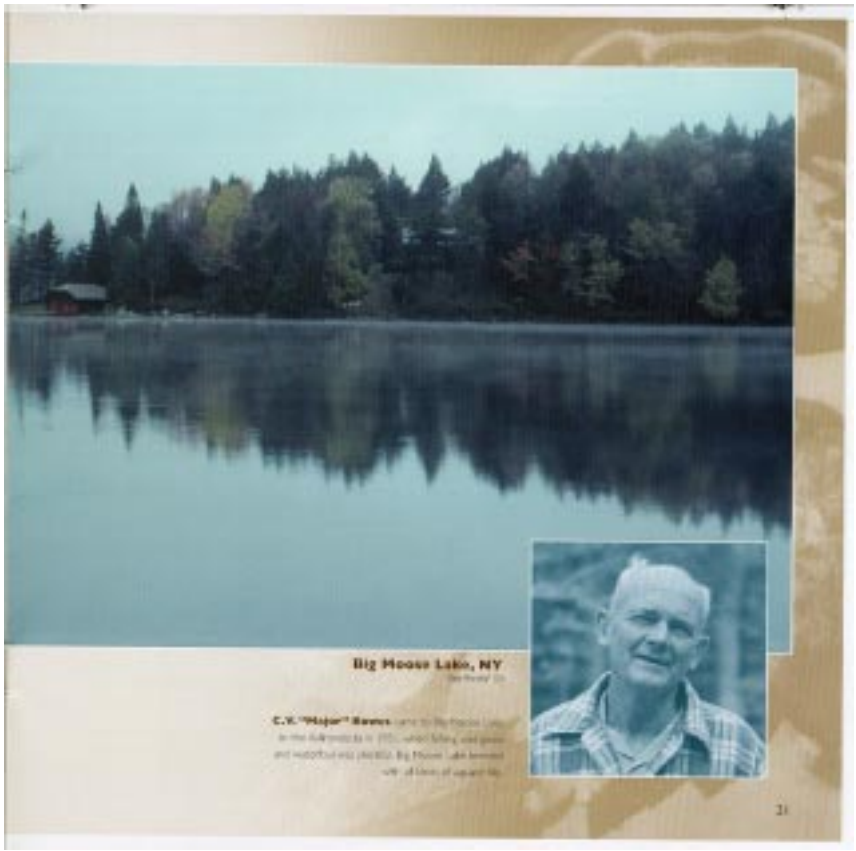
Trophy-sized brook trout, white fish, landlocked salmon and lake trout abounded, beckoning anglers from throughout the world to ply its remote, chilly waters. Acid rain has exterminated those fish species. Former natives such as crayfish, freshwater shrimp, frogs, hooded mergansers and otters are rarely seen anymore.

By 1980, the tourist hotel operators had given up on Big Moose Lake's fishing as a means of attracting tourists. They watched helplessly as millions of dollars in potential revenues dipped from their collective fingers. Worse yet, one lakeside business was about to discover that acid rain can make people sick, too.

Cowewood Lodge owners Diane and C.V. "Major" Bowes were dumbfounded when their children began complaining about the taste of their drinking water, which was drawn from a well next to the lake. When one of their young daughters developed stomach cramps and diarrhea, the Boweses had their water tested.

Test results showed the water contained five times as much lead as is deemed safe for human consumption. The water contained copper as well. Both metals were being leached out of the inside of their pipes and plumbing fixtures due to the corrosive water. Lead is highly toxic to humans. But copper also kills the beneficial bacteria that allow septic systems to break down wastes and purify wastewater. The Boweses now treat their water to make it safe for drinking.

In 1996, the NYS Dept. of Health began conducting tests of water supplies throughout the state. Health officials reported that nearly all of the lakes, ponds and reservoirs they tested for toxins in the Adirondacks and Catskills were at least slightly acidic. Often, the tests showed no chemical contamination in the source of the water, but high levels of lead and copper coming out the taps in people's homes.


Big Moose Lake, NY

How do we solve this problem! Given all of the damage done to our health and environment by acid rain and the toxic chemicals associated with it, it is unconscionable that this pollution is allowed to continue. But utility companies that burn coal and produce the most acid rain also produce the cheapest electricity in the country. This is a strong incentive to keep doing what they are doing. In 1990, the U.S. Environmental Protection Agency created an acid rain cap-and-trade program designed to reduce sulfur-dioxide emissions by 50 percent nationwide. We now know that this goal is too low. In addition, the federal government has done little to control nitrogen-oxide emissions from electric plants. Research has demonstrated that nitrogen-based air pollution is a major culprit in the destruction of many life forms in lakes, rivers and coastal estuaries. The good news is that there is a solution to this acid rain problem. Scientists in the Northeastern states and southern Canada agree that sensitive areas of the country would have a fighting chance of recovering from decades of pollution if utility companies reduce their sulfur-dioxide and nitrogen-oxide emissions by 70 to 75 percent below 1990 levels. Below are the solutions, a simpler and less expensive than most people think.

1. **Make the existing program work.** Private industry has already grown accustomed to the current sulfur-dioxide control program. Making the program work better would be more practical than trying to tear it down and start over. The program sets a cap on the total amount of pollution allowed nationwide and allows individual companies to buy and sell the rights to that pollution. This allows more wire-to-wire the largest and least expensive cuts to do so right away. They are then free to sell the rights to the pollution they don't emit. Over time, the total number of pollution rights (or allowances) issued by EPA will drop by 50 percent below 1990's pollution levels. **Action: Reduce the cap another 10 percent. This would bring the total reduction in pollution to 75 percent below 1990 levels.**

2. **Create a new pollution-trading program for nitrogen-oxides.** Creating a federal allowance-trading program similar to the sulfur-dioxide program would give utility companies a financial incentive to make deep cuts in emissions. **Action: Create a nitrogen-oxide pollution trading program that reduces nitrogen-based air pollution by 70 percent below 1990 levels.**

3. **Keep monitoring the results.** Cuts in emissions of sulfur have caused a drop in the amount of acid rain chemicals falling the ground. But some scientists have been unable to find the so-called deposition rate, and has resulted — nationwide or in a targeted geographic region — to ensure that they succeed in achieving any new cuts in sulfur, nitrogen and mercury should be coupled with monitoring of the effects of the cuts on the ground. **Action: Biological surveys and chemical tests should be performed on a regular basis at least through the year 2010 to ensure that the pollution cuts made in the meantime have the anticipated effect.**

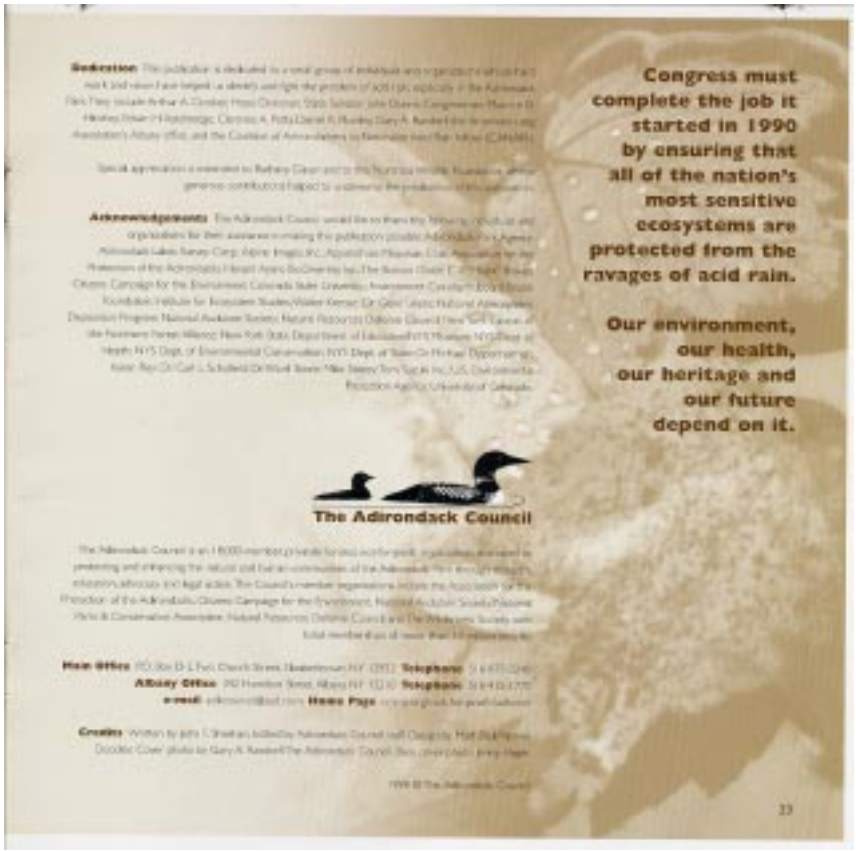
4. **Give EPA the authority to keep making cuts.** Congress expected EPA to fix the nation's acid rain problem when it approved the Clean Air Act Amendments of 1990. That did not happen and EPA has a hard time authority to enter deeper cuts on its own. **Action: EPA's Administrator should have explicit authority to order new cuts to protect human health and sensitive ecosystems without further Congressional action.**

What is all of this going to cost?

In 1990, utility companies said it would cost them a total of $6 billion a year to comply with the federal acid rain program. A recent study by the Massachusetts Institute of Technology showed that the actual cost of compliance is less than $800 million annually. That is less than one-seventh of the projected price. EPA projected in 1990 that allowances would trade for $1,200 to $1,500 per ton by now. The average cost in 1998 was less than $133.

Creating an allowance trading program to control both sulfur-dioxide and nitrogen-oxide emissions would be very attractive to utility companies and securities brokers, who can help as consultants. Congress is an right area — before more lakes and forests die.

For the same amount that we expected to spend as a nation just on sulfur-dioxide, we can reduce both sulfur-dioxide and nitrogen-oxides by 70 to 75 percent below 1990 levels and continue monitoring the results.



Dedication

Acknowledgements

Congress must complete the job it started in 1990 by ensuring that all of the nation's most sensitive ecosystems are protected from the ravages of acid rain.

Our environment, our health, our heritage and our future depend on it.

The Adirondack Council

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Credits

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