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Statement of
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We appreciate the opportunity to be here today to discuss GAO's work on acid rain. Accompanying me are Dr. Richard Frankel and Mr. Steven Elstein, of my staff, who have been primarily responsible for GAO's work on the acid rain issue. The work we are doing is at the request of Senator Ford of this Committee. We issued a report last September which focused on the debate surrounding acid deposition by examining allegations put forth by both sides of the debate in the light of our understanding of scientific knowledge on the key issues.

In our current study, which we expect to complete this fall, we are continuing this effort taking into account new information and are also examining the cost implications of alternative acid deposition control strategies. This work has consisted mainly of synthesizing and analyzing information from the many scientific and economic studies on the issue, with a particular focus on the assumptions that underlie their conclusions. We have also supplemented these data with our own interviews and calculations.

We should emphasize at this time that we are testifying today based on work in progress. Since our review is not completed yet, the findings we will discuss represent only our preliminary indications and could change somewhat as we complete our work.

Our findings today are organized to address what we view as the three central questions of this issue:

1. What are the present and anticipated damages due to acid deposition?

2. How well do we understand acid deposition's causes?

3. What would be the costs and other effects of proposed actions?

Effects of Acid Deposition

Our examination of damages associated with acid deposition shows a varied picture, spanning from clearly demonstrated impacts in some areas, to a paucity of data in others. In almost all damage categories, the lack of economic as well as scientific measurements have made it difficult to quantify present and potential damages.

In essence, we are finding that damage to aquatic ecosystems has been demonstrated beyond a reasonable doubt by the scientific community. On the other hand the existence and extent of damage in the other areas we looked at; terrestrial ecosystems, man-made materials and human health, have not been as clearly established. Considerable evidence shows that acid deposition has damaged lakes, streams and aquatic life in sensitive areas in the Northeast U.S. and Southeast Canada. Thus far we are finding that the damages to aquatic ecosystems due to acid rain, and its associated economic costs, have been limited geographically and are small in comparison to the total value of the aquatic resources in these regions. However, the weight of evidence on this continent, plus more widespread fishery losses in Scandinavia, suggest that future damage of a wider scope is likely in North America at current levels of deposition.

It is less clearly established, but scientific research suggests that acidic pollutants, particularly dry deposited SO2, are the single largest source of pollution-related damage to materials. This has less bearing on transported acids, however, because materials are predominantly located in developed areas where pollutant contributions are dominated by local emissions.

The extent of impacts on terrestrial ecosystems--that is, forests, crops, and soils--appears uncertain at this time. Scientists have identified ways in which deposited acid could damage these resources, either directly or by affecting their soils. However, clear evidence of damage due to acid deposition in the U.S. has generally only been confirmed in experiments on plants exposed to levels of acidity a good deal greater than those currently being experienced. One set of studies, however, has cited acid deposition as being responsible, at least in part, for damage in an experimental forest in West Germany.

Scientists have looked at possible human health impacts of both acid deposition and suspended sulfates, which are also derived from SO2 emissions. Deposited acids themselves appear to pose no direct health problems. The main health concern about acid deposition is its indirect role, by bringing about elevated levels of heavy metals in household water supplies and freshwater fish.

The problem detected in fish is mercury, sometimes in amounts above the levels considered dangerous. How acidified water contributes to this is not clear, but it has been reported on some occasions, particularly in poorly buffered lakes.

Water supplies which are acidified can dissolve copper and lead out of pipes. While treatment facilities can adjust acidity to avoid this problem, it is not so easily dealt with in individual water systems. Furthermore, wells and groundwaters have been found to be acidified in some regions in Sweden, a possibility which could be of concern in the U.S. We have only seen scattered reports evaluating effects on water supplies, with very little testing of individual systems or ground waters. Instances of health effects due to lead have been reported, but available information does not give a good sense of the scale or distribution of this problem.

Important questions at this point are: How much more severe will the problem get without corrective action? and, how quickly will it get more severe? We do not find good answers to these questions at this point.

Causes of Acid Deposition

We have looked rather thoroughly into the scientific understanding of how acid deposition comes about, and have found that some parts of the question are answered, some parts may not be answerable, and some parts have only partial answers at this time. We find that there is little doubt that fossil fuels are a major cause of acid deposition. Some questions persist, however, on just how this occurs, how pollutants travel and how far, and where corrective measures could be taken to best solve the problem.

Overall global patterns of acid deposition show that eastern North America is one of three regions of the world with widespread high acid deposition. Historic evidence, in glaciers and lake sediments, shows that this is a relatively new pattern, not seen before the industrial revolution. Since then, man's sulfur and nitrogen oxide emissions have gone up to about match natural ones overall, and to dominate them in the industrial regions. Indeed, the Electric Power Research Institute has found that man-made sources are responsible for over 90 percent of total sulfur emissions in the eastern U.S.

In the eastern U.S., about two-thirds of the acid deposited in precipitation, also called wet deposition, is sulfuric acid, with most of the balance nitric acid. Biologists find that a large portion of the nitric acid is absorbed as a nutrient and neutralized by plants. In addition to the sulfuric acid which comes down as wet deposition, another share believed to be about the same size is deposited dry, mostly as unaltered SO2 gas. In biological systems, dry deposited SO2 seems to be a source of acidity just like wet deposition, apparently because it gets oxidized to sulfuric acid soon after it is wetted on plants or in the ground. Therefore, biologists find that deposition of the sulfur compounds is the main problem in effects on natural ecosystems.

Scientific studies indicate that acidification of natural ecosystems is a cumulative process, with visible damage usually not detected until after many years or decades of deposition. The first major growth of SO2 emissions in the U.S. occurred around the beginning of this century, which would indicate that acidification has been progressing for a half-century or more. The appearance of damage now in some of the most sensitive areas suggests that the end point may not be much further off for other areas which have not yet shown actual damage.

A major question has been whether deposition is "linear", that is, whether it would be changed in proportion to changes in emissions. We find that two studies that have examined this question most closely have reached somewhat different conclusions. While dry deposition is generally recognized to be essentially linear, one study found that wet deposition is close to linear and the other that its about half linear. We believe more work needs to be done on this question.

On the question of transport, and source-receptor relationships, accurate quantitative results must await further work with the complex regional models that have been developed in recent years. However, atmospheric studies show that air movements vary, so that on the average, emissions from any source will spread and contribute to deposition over a wide region, with a preference toward the direction of prevailing winds. European studies indicate that substantial downwind wet deposition occurs at ranges of at least 500 to 700 miles, and that a number of lower emission countries received more deposition from the combined contributions of other countries than from their own emissions. However, in almost all cases, each country provided the largest single share of its own deposition. This fits with the preliminary results of North American modeling, which tends to show that important contributions to wet deposition come from both shorter and longer range transport, with a greater range in the eastward and northeastward direction.

Possible Control Actions

As you know, various proposals have been introduced in Congress this year which would require state-by-state emission reduction targets. Our review and analysis of the literature, and our interviews and calculations lead us to the following tentative findings:

1. A strategy of setting state-by-state emission reduction targets would likely employ a diverse number of methods, since the costs of different methods vary greatly with location and other criteria. This would be more cost-effective than prescribing individual control methods such as coal washing, switching, or scrubbing.

2. Higher levels of reduction disproportionately increase costs, because cheaper methods eventually become exhausted, and emitters must then go to more expensive techniques. According to the studies we have reviewed, the incremental cost of removing each succeeding ton of SO2--that is, the marginal cost--increases rapidly above about 5 or 6 million tons per year.

3. For an SO2 emission reduction program on the order of 10 million tons per year in the eastern U.S., total annual costs would be approximately $3 to $4.5 billion 1980 dollars. This is a least-cost estimate which would not necessarily account for additional features of any particular legislative proposal.

4. Coal production and employment impacts of such a program depend heavily on the combination of control methods used. To the extent that scrubbing or coal washing is used, local coal production will be protected. We expect, however, that switching would be very appealing to many utilities because of its lower costs, so that some job displacement and coal production losses will occur in high-sulfur coal regions. These effects would likely be partially mitigated in a few areas by increased mining of low-sulfur coal.

5. Electricity rate increases in states most affected by a 10 million ton reduction program would likely average on the order of 10 to 15 percent. Individual utility systems, however, which rely heavily on coal-fired capacity, could sustain substantially higher increases.

Regarding the cost impacts of particular emission control strategies, we are reviewing the techniques most likely to be used by utilities if further SO2 emission reductions are required: i.e., coal washing, flue gas desulfurization, or "scrubbing," and switching to lower-sulfur coals. We are also reviewing the benefits and limitations of liming.

Coal Washing

Coal washing is already being successfully used by some coal companies in the Midwest. This technique can produce moderate SO2 emission reductions for high-sulfur coal, at a relatively low cost. Some high-sulfur coals can be washed for $200 to $400 per ton of SO2 removed. In addition, coal washing's side-benefits are well documented--it increases the Btu content per pound of coal and eliminates some of the ash, thereby reducing transportation costs, storage and handling costs, and improving boiler operation and maintenance.

Despite these benefits, coal washing has limitations. Among them:

--It is substantially less efficient with lower-sulfur coals. For some low-sulfur coals, for instance, SO2 removal through coal-washing could cost several thousands dollars per ton of SO2 removed.

--A lot of high-sulfur coal is already being washed in some states. According to one report prepared for EPA, 72 percent of Illinois utility coal and 52 percent of Indiana utility coal was being washed before delivery in 1979. It is unlikely that substantial further SO2 emission reductions can be achieved in these states through coal washing.

--The total potential emission reductions that coal washing alone could produce are not very large. An upper limit would be about 2.5 million tons of SO2, which would amount to less than 12 percent of SO2 emissions in the 31 eastern states. Moreover, this would include some lower sulfur coals, so the average cost per ton of SO2 removed would be raised significantly.

Still, coal washing can be useful where high-sulfur coal is currently being burned without being washed.

Scrubbing

Scrubbing flue gases from existing powerplants is the most technically efficient--and capital intensive--means of reducing SO2 emissions commonly available today. While scrubbing has, to date, mostly been applied to meet New Source Performance Standards in new powerplants, it has been or is being retrofitted in a number of older U.S. plants, amounting to about 10,000 megawatts of generating capacity.

While it can remove 90 percent of a powerplant's SO2 emissions, at a cost of about $250 to $500 per ton of SO2 removed, the biggest drawback of retrofitting scrubbers is the high cost of this much greater level of SO2 reduction. The cost of retrofitting a conventional limestone system would generally range from about $140 to $250 per kilowatt, but could exceed

$300 per kilowatt in some cases. For an individual powerplant, this translates into a range of $140 to over $300 million for two 500 megawatt units.

The lower end of this range reflects a situation where few problems, particularly space constraints, are encountered in construction. The upper bound reflects situations where adequate space is not conveniently available for scrubbing equipment and support facilities. In this case, the so-called "retrofit cost penalty" could be very high--up to 150 percent, according to the Industrial Gas Cleaning Institute.

Low Sulfur Coal

Switching to low-sulfur coals, by major eastern coal-burning facilities, could produce large reductions in SO2 emissions at relatively low capital cost. The major issues associated with large-scale switching would be higher fuel costs and adverse employment in high-sulfur coal regions.

A variety of studies have indicated that this strategy's cost-effectiveness to utilities compares favorably with coal washing or scrubbing. But of greater concern to many high-sulfur coal companies, coal miners, and high-sulfur coal regions are potential coal production and employment losses, and other secondary impacts, caused by a shift to lower-sulfur coal.

DOE calculated that about 5,000 to 6,000 high sulfur coal miners would be affected for each million tons of SO2 reduced by switching. These figures suggest considerable employment impact for any SO2 reduction program which heavily relies on switching. Two factors, however, would partially offset these effects.

--projected long-term increases in eastern coal production are expected over the next two decades.

--in some areas, such as West Virginia, the availability of new or expanded low-sulfur coal mines might help to alleviate some of the effects in nearby high-sulfur coal mines.

Overall, though, we would expect that coal production and mining related employment, particulary in high-sulfur coal regions such as Illinois, Indiana, Ohio and Western Kentucky, would be affected by any large scale-utility shifts to low-sulfur coal. Even in West Virginia, it would be an oversimplification to say that the negative effects in one part of the state could be offset by the positive effects in the other.

Liming

Liming has been suggested as an alternative to reducing emissions to deal with acid deposition's effects. Among its benefits, it is less expensive than controlling emissions and its positive effects are experienced more quickly. A report prepared for the Electric Power Research Institute estimates combined materials and application costs of liming to be about $100 per acre. Sweden expects to lime about 20,000 acid-stressed bodies of water in 1986, at a cost of about $40 million, according to this report.

On the negative side, liming's effects are temporary, with repeated applications needed every three or four years. Furthermore, its potential to reduce possible large-scale lake and forest damage would be limited.

This concludes my statement on our tentative findings on acid deposition's effects, causes, and the costs of alternative control options. I would also like to inform the committee that GAO has been asked by the House Committee on Science and Technology to review the progress of the Administration's Interagency Task Force on Acid Precipitation. We are starting that review now and expect to report early next year.

I would now be happy to answer any questions.