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MASTER

# THE PREVENTION OF SIGNIFICANT DETERIORATION: IMPLICATIONS FOR ENERGY RESEARCH AND DEVELOPMENT

PREPARED FOR THE
DIVISION OF POLICY ANALYSIS
OFFICE OF ENVIRONMENT
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OFFICE OF ENVIRONMENTAL POLICY ANALYSIS

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# The Prevention of Significant Deterioration: Implications for Energy Research and Development

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## PREFACE

This report examines the implications of those portions of the Clean Air Act Amendments of 1977 concerned with preventing significant deterioration of air quality; the contents reflect 1977 legislative provisions and regulatory developments as of January 15, 1978. Because the work was performed for the Department of Energy's predecessor, the Energy Research and Development Administration, emphasis is placed on implications of the legislation for energy research and development; future work will examine a broader spectrum of energy policy considerations related to energy supply and utilization, as well as the relationship to other provisions of the Clean Air Act Amendments such as non-attainment of air quality standards, new source performance standards, and requirements for best available control technology. The report was prepared as part of an ongoing study of the implications of air quality policies, legislation, and regulations for national energy goals.

Analysis provided in the report draws upon the results of a workshop which the Office of Environmental Policy Analysis of Argonne National Laboratory (OEP/ANL) held at Airlie House, Airlie, Virginia in January, 1977. A description of the workshop will be found in Appendix A. Appendix B consists of an annotated bibliography of studies of the Prevention of Significant Deterioration, initially prepared for the workshop, updated to December, 1977.

ACKNOWLEDGMENTS

Richard R. Cirillo of Argonne's Energy and Environmental Systems Division prepared an initial paper outlining important issues in the Prevention of Significant Deterioration for energy development in October, 1976.

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Reviews of the final report were contributed by John H. Gibbons and William Chandler, Environment Center, University of Tennessee; Maria Grimes, Congressional Research Service; David Litvin, Division of Policy Analysis, Department of Energy; Arthur Stern, the School of Public Health, University of North Carolina; Weston Vivian, Institute of Public Policy Studies, University of Michigan; and Gary Widman, Hastings College of Law.

## GLOSSARY

| | | |
|---|---|---|
| ANL | - | Argonne National Laboratory |
| BACT | - | Best Available Control Technology |
| Btu | - | British Thermal Unit |
| CAAA | - | Clean Air Act Amendments |
| DoE | - | Department of Energy |
| ECT | - | Environmental Control Technology |
| EDP | - | Environmental Development Plan |
| EEA | - | Energy and Environmental Analysis, Inc. |
| EPA | - | Environmental Protection Agency |
| ERDA | - | Energy Research & Development Administration |
| ERT | - | Environmental Research & Technology, Inc. |
| ESECA | - | Energy Supply & Environmental Coordination Act |
| ESP | - | Electrostatic Precipitator |
| FBC | - | Fluidized-Bed Combustion |
| FEA | - | Federal Energy Administration |
| FGD | - | Flue-Gas Desulfurization |
| FPC | - | Federal Power Commission |
| kW(h) | - | Kilowatt (hour) |
| LAER | - | Lowest Achievable Emission Rate |
| MHD | - | Magnetohydrodynamics |
| $\mu g/m^3$ | - | Micrograms per cubic meter |
| mm | - | Million |
| MW | - | Megawatt |
| NAAQS | - | National Ambient Air Quality Standards |
| NERA | - | National Economic Research Associates, Inc. |
| NESHAPS | - | National Emission Standards for Hazardous Pollutants |
| NSPS | - | New Source Performance Standards |
| Pollutants | - | $NO_x$ (nitrogen oxides); HC (hydrocarbons); CO (carbon monoxide); $O_x$ (oxidants); TSP (total suspended particulates); $SO_2$ (sulfur dioxide) |
| PSD | - | Prevention of Significant Deterioration |
| RD&D | - | Research, Development and Demonstration |
| SIP | - | State Implementation Plan |
| TVA | - | Tennessee Valley Authority |

# EXECUTIVE SUMMARY

The Clean Air Act Amendments of 1977 contain provisions designed to prevent the significant deterioration of air quality in areas of the nation where the ambient air is cleaner than the minimum levels required to meet National Ambient Air Quality Standards (NAAQS). The legislation will affect the economic competitiveness of alternative fuel cycles for the generation of power and will have implications for the future siting of all new major sources of emissions. This paper examines the potential effects of Prevention of Significant Deterioration (PSD) legislation on energy technologies and industrial facilities and, in particular, the possible effects on energy research and development programs of the Department of Energy (DoE).

PSD legislation establishes three area classification designations--Classes I, II and III -- for clean-air portions of the country, stipulating maximum allowable total future increases in the air pollutant concentration of sulfur dioxide and total suspended particulates for each area. In Class I, or pristine areas, only a very small increment will be permitted; in Class II, a moderate increment, associated with moderate growth, will be permitted; and in Class III, the largest increment will be permitted, to allow maximum economic growth, although in no case will the increase be allowed to exceed the NAAQS level. The increments apply relative to a baseline level of air quality defined as the measured or estimated ambient pollutant concentrations in that area at the time of the first PSD permit application. National parks and certain other areas are mandated as Class I; all other areas are to be Class II unless redesignated by an appropriate authority (State or Indian tribe). Compliance with Class I increments may be waived if the owner of a proposed new source can demonstrate to the satisfaction of the authority responsible for the area that emissions will not adversely affect air quality related values (including visibility). In addition, a waiver from compliance with the short-term (3 hour and 24 hour) sulfur dioxide increments for a Class I area may be granted for a maximum of 18 days in any annual period, within certain statutory limits.

The legislation requires a preconstruction review of all new major sources of emissions within twenty-eight specified categories or with the potential to emit significant amounts of pollution. The review procedure will require a new source to use the best available control technology, as determined by the permitting authority. Air quality modeling will be used to determine whether emissions from the new facility will exceed the allowable increments for the area classification of the site or will cause pollutant concentrations in any neighboring Class I area to exceed the established limits. If modeling predicts a violation, a construction permit will be denied unless the proposed emissions are reduced further or the source is relocated to an alternative site. The owner or operator of a proposed facility is responsible both for proving that the new source will not exceed maximum concentrations or violate standards and for monitoring and measuring emissions from his operations.

The following effects of PSD have been identified:

*Economic*. The capital and operating costs of compliance with PSD will result in an estimated 4% increase in the costs of electricity per household (both on utility bills and in the price of goods and services purchased) in 1990 compared to costs without PSD, or an additional $48 (annual average) in 1990. Approximately 40% of this increase, however, is a result of more stringent emission limitations and the use of control technology, in particular flue-gas desulfurization systems, that will more than likely be required anyway by revisions in the New Source Performance Standards (NSPS) for coal-fired power plants.

*Facility Siting/Size.* Constraints on siting and size of proposed facilities will result from area designations and from the need to locate at some minimum distance from a Class I area. The maximum additional electric generating capacity which can be accommodated in a Class II area with flat or moderate terrain has been estimated as 2,700 MW, assuming no other major facilities are constructed and that the power plant achieves emission limitations required by the present (Dec. 1977) NSPS. Since emissions will be reduced further by the use of "best available control technology," as required in a PSD review, this maximum size would increase. In flat terrain, the emissions from one commercial-size coal gasification plant (250 million standard cubic feet per day) or one oil shale plant (50,000 barrels per day), in compliance with existing NSPS, would not violate Class II increments. In rugged terrain, the maximum size of a facility is reduced since the emissions are "trapped"; the degree of pollution concentration depends on the elevation relative to the stack height of the power plant. These estimates of maximum sizes assume that the entire increment for a Class II area would be available to the new source. Siting constraints will become more restrictive as PSD increment ceilings are reached. If increments are allocated on a first-come, first-served basis, technologies which are presently in the research and development stage may face difficulties in locating sites for commercial-scale facilities in the future.

Separation distances from a Class I area for a new 1,000 MW coal-fired plant, with emissions of a range from 0.12 to 0.46 lb of sulfur dioxide per million Btu in comparison to the 1.2 lb limitation of the present NSPS, have been estimated at 5 to 20 miles in flat or moderate terrain and at 25 to 42 miles in more rugged terrain. The size and number of Class I areas in the western United States, coupled with the typical hilly terrain, will limit the choices of sites for new sources in those areas. Since a substantial number of coal conversion facilities (such as gasification and liquefaction) and all oil shale development is expected to be located in the West, PSD may place significant constraints on the choices of sites for these activities. The variance provisions may relax these constraints,but the need to protect visibility in these areas may make it difficult to obtain a variance.

*Alternative Energy Technologies.* The cost of compliance with increasingly stringent emission limitations required by either revised NSPS or a PSD review will affect the competitive cost positions of alternative fuel cycles for the generation of power. Some coal conversion technologies, such as solvent refined coal and liquefaction, may have difficulty achieving the more stringent sulfur dioxide standards. A number of studies have suggested that nuclear power may become a least-cost option in some areas in comparison to conventional coal combustion under air quality regulations. The PSD requirements can be expected to encourage the development of improved control technologies; of those combustion technologies which have lower emission levels or less expensive emission control options; and of technologies which are inherently less polluting, such as solar and geothermal energy, especially as PSD increment ceilings are reached. Siting constraints and the cost of compliance will encourage measures to increase efficiency in the use of energy.

*Industrial and Energy Growth.* The long-term effects of PSD are uncertain and depend, to a large extent, on the implementation of the legislation. If stringent emission limitations are required by BACT (or NSPS), more facilities can be constructed within the allowable increments. The ability of states or other authorities to redesignate land to either Class I or Class III will affect the amount of new development possible. As increment ceilings are approached, conservation and increased efficiency in the use of energy will become increasingly important in reducing energy demand and the need for new facilities.

*Environment.* The effects of PSD on energy development must be viewed in comparison to the stated goals of PSD legislation — to protect public health and welfare from air pollution above and beyond national ambient air standards; to preserve, protect and enhance air quality in unique public land areas; to ensure that economic growth will not conflict with air quality goals and that air quality goals not preclude economic growth; and to assure that increases in air pollution are allowed only after careful evaluation and public participation.

PSD legislation can be expected to affect DoE's research and development programs by 1) accelerating development of those fossil-fuel technologies which have lower emission levels or can achieve emission limitations at lower cost, such as fluidized-bed combustion; 2) encouraging the development of alternative control technology, such as regenerable scrubbers; and 3) increasing the importance of the development of alternative fuel cycles that are inherently cleaner, such as nuclear or solar. The magnitude of these effects will largely depend on the implementation of the legislation -- how increments will be allocated, how areas are redesignated, and how BACT is defined -- as well as on the reliability and accuracy of measuring and monitoring efforts, the long-range development goals of individual regions, and the future development of energy-efficient and non-polluting production technologies by industries and utilities.

In response to these effects, DoE can adopt different strategies:

1. Continuation of energy research and development programs, treating PSD as a constraint only when the legislation affects the siting of a particular technology.

2. Initiation of a more constructive approach towards achieving both environmental and energy goals by, for example:
   - Analyzing new energy technologies for emissions of all pollutants and for potential control technology.
   - Preparing an ongoing summary of BACT determinations and the associated costs as they occur in PSD reviews.
   - Addressing the possibility that some sites may be unavailable in the future as PSD increments are used up by examining, for example, background levels of pollutants, topography and area designations, or by forecasting the future amounts of increments available.
   - Examining the interrelationship of PSD, nonattainment requirements and revisions in the NSPS and evaluating the overall impact on energy development.
   - Expanding research and development into emission control technologies for conventional fossil-fuel combustion.
   - Redirecting some program goals from coal technologies to nuclear and/or renewable energy sources and to energy conservation.

3. In addition to all of 2, anticipation of future environmental requirements resulting from the implementation of PSD regulations and other air quality regulations, by initiating programs to analyze the health and environmental effects of coal combustion and of newer energy technologies.

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## I. IMPORTANCE OF PSD

*Issues for the Department of Energy*

*How will PSD affect the Department of Energy?*

The Clean Air Act Amendments of 1977 contain provisions designed to prevent the significant deterioration of air quality in areas of the nation where the ambient air is cleaner than the minimum levels required to meet National Ambient Air Quality Standards (NAAQS). By limiting the total increase in pollution levels in such regions, the legislation seeks to ensure that economic growth will not interfere with air quality goals. The Prevention of Significant Deterioration (PSD) provisions will directly affect the future siting of all new power generating facilities and other new major sources of emissions in these areas, as well as the choice and economic competitiveness of alternative fuel cycles.

The legislation can be expected to affect the comparative emphasis on and priorities of many RD&D programs of the Department of Energy (DoE), accelerating development of better emission control technology for fossil energy systems and encouraging development of those alternative fuel cycles (including nuclear and solar) and fossil fuel power generation technologies (including fluidized-bed combustion) which are inherently less polluting or which require less expensive emission control. As PSD increment ceilings are approached, measures to improve efficiency in the use of energy will be encouraged.

*National Environmental Objectives*

*Environmental consequences of economic growth should be considered.*

Consideration of the environmental consequences of economic growth and production is a relatively new concept in U.S. law. The National Environmental Policy Act of 1969 required that environmental impacts be considered as decision-making factors in Federal actions along with socio-economic, technical and other considerations.[1] Legislation establishing the Department of

Energy reiterated this goal, requiring "incorporation of national environmental protection goals in the formulation and implementation of energy programs ... to advance the goals of restoring, protecting and enhancing environmental quality and assuring public health and safety."[2]

*DoE is charged with achieving energy goals without degrading the environment.*

The National Energy Plan* stated that "the Administration intends to achieve its energy goals without endangering the public health or degrading the environment."[3] The Department of Energy is committed to research, development, and demonstration programs aimed at providing alternative energy choices for the future that are environmentally acceptable. In order to evaluate the environmental soundness of developing energy technologies, the Department of Energy's predecessor, the Energy Research & Development Administration, established the Environmental Development Plan (EDP) in 1976.[4] EDP's are required for selected programs in four energy technology areas (fossil; conservation; solar, fusion and geothermal; and nuclear), to identify and characterize emissions and potential environmental impacts. The EDP's include strategies for resolving environmental, health and safety issues. Thirty-two plans have been prepared thus far. Early appraisal of the environmental impacts of an energy system and possible abatement strategies will help to ensure that a system can meet applicable environmental regulations when it is commercially available. The balance between the protection of air quality and the development of new coal combustion technologies is one of the many complex issues facing DoE. DoE needs to consider the role of air quality legislation, such as PSD, in its energy development programs.

*Philosophy of PSD*

*Air quality legislation initially concentrated on cleaning up dirty air.*

National concern for the maintenance of air quality and for controlling air pollution was first expressed in the Clean Air Act of 1963. Initially, efforts were concentrated on cleaning up the dirty air regions, with little thought given to prevention of deterioration of the clean regions. One clear purpose of the

* Submitted to Congress by President Carter in April, 1977.

*National Ambient Air Quality Standards were set.*

Clean Air Act Amendments of 1970 was to reduce air pollution in polluted areas to levels that were considered acceptable. As a result, the Environmental Protection Agency (EPA) promulgated National Ambient Air Quality Standards (NAAQS), specifying the permissible concentrations of pollutants at ground level for various time periods. (NAAQS were subdivided into primary standards, to protect public health, and secondary standards, to protect public welfare. Each state was required to submit a State Implementation Plan (SIP) outlining how the NAAQS were to be achieved and maintained.)

*But what would happen to areas where the air was cleaner than the standards?*

The legislation had also introduced a new goal "to protect and enhance the quality of the Nation's air resources ...,"[5] implying that deterioration of air quality in clean air areas was also to be avoided, but without explaining the intent of Congress or requiring specific enforcement procedures. The specter of industries "moving to these areas and fouling the air there to the levels of the national standards"[6] led to a Sierra Club suit against EPA. EPA was subsequently required by the courts to establish regulations to prevent air quality deterioration which would be considered "significant." PSD regulations were promulgated in 1974. Numerous law suits followed, with environmental groups demanding stricter interpretations of significant deterioration and stronger action, while utilities and other industries objected to the regulations as amounting to a "no-growth policy." The regulations were upheld by the courts, however.

In the 1977 Clean Air Act Amendments, Congress established provisions to prevent the significant deterioration of air quality in clean air areas, to provide protection against health and environmental effects not anticipated by the NAAQS, and to preserve some areas of the country "as clean as God created ... [them]..."[7]

*What is the rationale behind PSD?*

The concept was thus introduced into law not only of putting right the things that were wrong with air quality, but of preventing the same situations from occurring in clean areas. The difficulties confronted in cleaning up existing polluters only confirmed the need to prevent air quality degradation rather than cure it after the degradation had occurred. The air quality "cushion" between existing air quality levels and those limits specified for protection of health and welfare is recognized as something of value and in need of protection. If air quality is regarded as a finite natural resource, only a certain amount of it can be "used up" before health and welfare become threatened. These available resources of clean air need to be protected and should be allocated carefully among future requirements to maintain a deliberate balance between industrial growth and environmental quality.

Senator Muskie, Chairman of the Senate subcommittee responsible for the legislation, summed up the philosophy behind PSD:

> There is just so much air, just as there is so much coal and so much oil. The question is, do we want to discipline in any way at all the pace at which and the directions in which we use them up? If we do not have a nondegradation policy, my view is that we are going to make the same mistakes in the clean air areas of the country ... as we made in the New Yorks and Los Angeleses of today.[8]

## II. PSD LEGISLATION

The Prevention of Significant Deterioration of Air Quality (PSD) provisions form sections 160-169A of Title I of the Clean Air Act Amendments of 1977 (PL 95-95, 42 USC 7401 et seq).

These individual sections cover:

160 Purposes
161 Plan requirements
162 Initial classifications
163 Increments and ceilings
164 Area redesignation
165 Preconstruction requirements
166 Other pollutants
167 Enforcement
168 Period before plan approval
169 Definitions
169A Visibility protection for Federal Class I areas

These are all additions to the Clean Air Act Amendments of 1970, in which there was no equivalent parts. Summaries of these sections follow.

*Section 160:Purposes*

*What are the purposes of PSD?*

Five distinct purposes of PSD are given:

(i) to protect public health and welfare from air pollution above and beyond national ambient air quality standards;

(ii) to preserve, protect, and enhance air quality in certain natural areas;

(iii) to ensure that economic growth will not conflict with air quality goals;

(iv) to prevent undue pollution from one state affecting a neighboring state; and

(v) to assure that any permission given to increase air pollution is made only after careful evaluation and public participation.

*Section 161: Plan Requirements*

Each State Implementation Plan is to contain emission limitations to prevent significant deterioration of air quality.

*Section 162: Initial Classifications*

*Mandatory Class I (pristine) areas are established.*

All international parks, national wilderness areas which exceed 5,000 acres, national memorial parks which exceed 5,000 acres, and national parks which exceed 6,000 acres shall be Class I areas and may not be redesignated. (See Table 1 and Figure 1.) All other areas shall be Class II areas unless redesignated under Section 164.

*Section 163: Increments and Ceilings*

*Three class designations are set with increases in $SO_2$ and TSP pollution to be limited to specified amounts.*

The maximum allowable increases in pollutant concentration over the baseline concentration (defined in Section 169) are found in Table 2. The maximum allowable concentrations shall not exceed the primary or secondary NAAQS, whichever are lower.

With the approval of EPA, states may exempt from increment usage emissions from (i) sources converting to coal from oil or gas under the Energy Supply and Environmental Coordination Act or a natural gas curtailment plan; (ii) construction or other temporary sources; and (iii) sources outside the United States. The conversion exemptions shall apply for no more than five years.

*Section 164: Area Redesignation*

Areas that exceed ten thousand acres in size and that are national monuments, national primitive areas, national preserves, national recreation areas, national wild and scenic rivers, national wildlife refuges, national lakeshores or seashores, or new national parks and wilderness areas may only be redesignated from Class II to Class I.

TABLE 1

MANDATORY CLASS I AREAS*

**National Parks over 6,000 acres**

*Alaska* — Mt. McKinley National Park, 1,939,492 acres.
*Arizona* — Grand Canyon, 902,557; Petrified Forest, 94, 189.
*California* — King's Canyon, 460,122; Lassen Volcanic, 106,372; Redwood, 62,304; Sequoia, 386,823; Yosemite, 761,096.
*Colorado* — Rocky Mountain, 261,985; Mesa Verde, 52,000.
*Florida* — Everglades, 1,400,533.
*Hawaii* — Hawaii Volcanoes National Park, 229,177; Haleakala National Park, 27,823.
*Idaho* — Yellowstone (Mountain, Wyoming), 2,219,822.
*Kentucky* — Mammoth Cave, 51,310.
*Maine* — Acadia, 36,980.
*Michigan* — Isle Royale, 539,279.
*Minnesota* — Voyageurs, 219,128.
*Montana* — Glacier, 1,013,595; Yellowstone (Idaho, Wyoming), 2,219,822.
*New Mexico* — Carlsbad Caverns, 46,755.
*North Carolina* — Great Smokey Mountains (Tennessee), 517,014.
*Oregon* — Crater Lake, 160,290.
*South Dakota* — Wind Cave, 23,000.
*Tennessee* — Great Smokey Mountains (North Carolina), 517,014.
*Texas* — Big Bend, 709,088; Guadalope Mountains, 79,972.
*Utah* — Arches, 73,388; Bryce Canyon, 36,010; Canyon Lands, 337,559; Capitol Reef, 241,865; Zion, 147,000.
*Virginia* — Shenandoah, 190,420.

*Washington* — Mount Ranier, 235,404; North Cascades, 504,785; Olympic, 897,884.
*Wyoming* — Grand Teton, 310,418; Yellowstone (Montana, Idaho), 2,219,822.

**National Wilderness Areas over 5,000 acres**

*Alabama* — Sipsey River, 12,000 acres.
*Alaska* — Bering Sea National Wilderness, 41,113; Tuxedni, 6,402; Simeonof, 25,141.
*Arizona* — Chiricahua, 18,000; Galiuro, 53,000; Mazatzal, 206,000; Mount Baldy, 7,000; Petrifield Forest Wilderness, 93,492; Pine Mountain, 20,000; Sierra Ancha, 21,000; Superstition, 124,000; Sycamore Canyon, 48,000.
*Arkansas* — Caney Creek, 14,000; Upper Buffalo, 11,000.
*California* — Aqua Tibia, 16,000; Caribou, 19,000; Cucamonga, 9,000; Desolation, 63,000; Dome Land, 62,000; Emigrant, 106,000; Hoover, 43,000; John Muir, 500,000; Lassen Volcanic Wilderness, 79,000; Lava Beds Wilderness, 28,000; Marble Mountain, 215,000; Minarets, 110,000 Mokelumne, 50,000; San Gabriel, 36,000; San Gorgonio, 35,000; San Jacinto, 22,000; San Rafael, 143,000; South Warner, 70,000; Thousand Lakes, 16,000; Ventana, 95,000; olla Bolly-Middle Eal, 110,000.

*Colorado* — La Garita, 48,000; Maroon Bells — Snowmoss, 71,000; Mount Zirkel, 72,000; Rawah, 28,000; West Elk, 61,000; Weminuche, 400,907; Flat Tops, 235,230; Eagles Nest, 133,910; Great Sand Dunes, 33,450.
*Florida* — Bradwell Bay, 22,000; Saint Marks, 17,750; Okefenokee (Georgia) 343,000.
*Georgia* — Okefenokee (Florida); Cohutta (Tennessee), 35,000; Wolf Island, 5,100.
*Idaho* — Craters of the Moon Wilderness, 43,000; Sawtooth, 216,000; Selway — Bitterroot, 1,240,000.
*Kentucky* — Beaver Creek, 5,500.
*Louisiana* — Breton, 5,000.
*Michigan* — Seney, 25,000.
*Minnesota* — Boundary Water Canoe, 747,840.
*Montana* — Anaconda — Pintlar, 158,000; Bob Marshall, 950,000; Cabinet Mountains, 94,000; Gates of the Mountains, 29,000; Mission Mountains, 75,000; Scapegoat, 240,000; Red Rock Lakes, 32,350.
*Nevada* — Jarbidge, 65,000.
*New Hampshire* — Great Gulf, 6,000; Presidential Dry Range, 20,000.
*New Jersey* — Brigantine, 6,600.
*New Mexico* — Bosque — Del Apache, 30,850; Gila, 434,000; Pecos, 168,000; San Pedro Park, 41,000; Wheeler Peak, 6,000; White Mountain, 31,000.
*North Carolina* — Joyce Kilmer Slickrock (Tennessee), 15,000; Linville Gorge, 8,000; Shining Rock, 13,000.
*North Dakota* — Lostwood, 5,500.
*Oregon* — Diamond Peak, 35,000; Eagle Cap, 294,000; Gearheart Mountain, 19,000; Kalmiopsis, 77,000; Mount Hood, 100,000; Mt. Jefferson, 14,000 Mount Washington, 47,000; Mountain Lakes, 23,000; Strawberry Mountain, 34,000; Three Sisters, 197,000.
*South Carolina* — Cape Romain, 28,000.
*Tennessee* — Cohutta (Georgia); Joyce Kilmer Slickrock North Carolina.
*Vermont* — Bristol Cliffs, 6,500; James River Face, 8,000.
*Virginia* — James River Face, 8,000.
*Washington* — Glacier Peak, 465,000; Goat Rocks, 83,000; Mount Adams, 32,000; Pasayten, 505,000; Alpine Lakes, 303,508.
*West Virginia* — Dolly Sods, 10,250; Otter Creek, 20,000.
*Wisconsin* — Rainbow Lake, 6,000.
*Wyoming* — Bridger, 383,000; North Absaroka, 351,000; Teton, 564,000; Washakie, 691,000; Fitzpatrick, 191,103.

**International Parks (none over 5,000 acres)**

*Maine* — Roosevelt — Campobello, 2,721 acres.

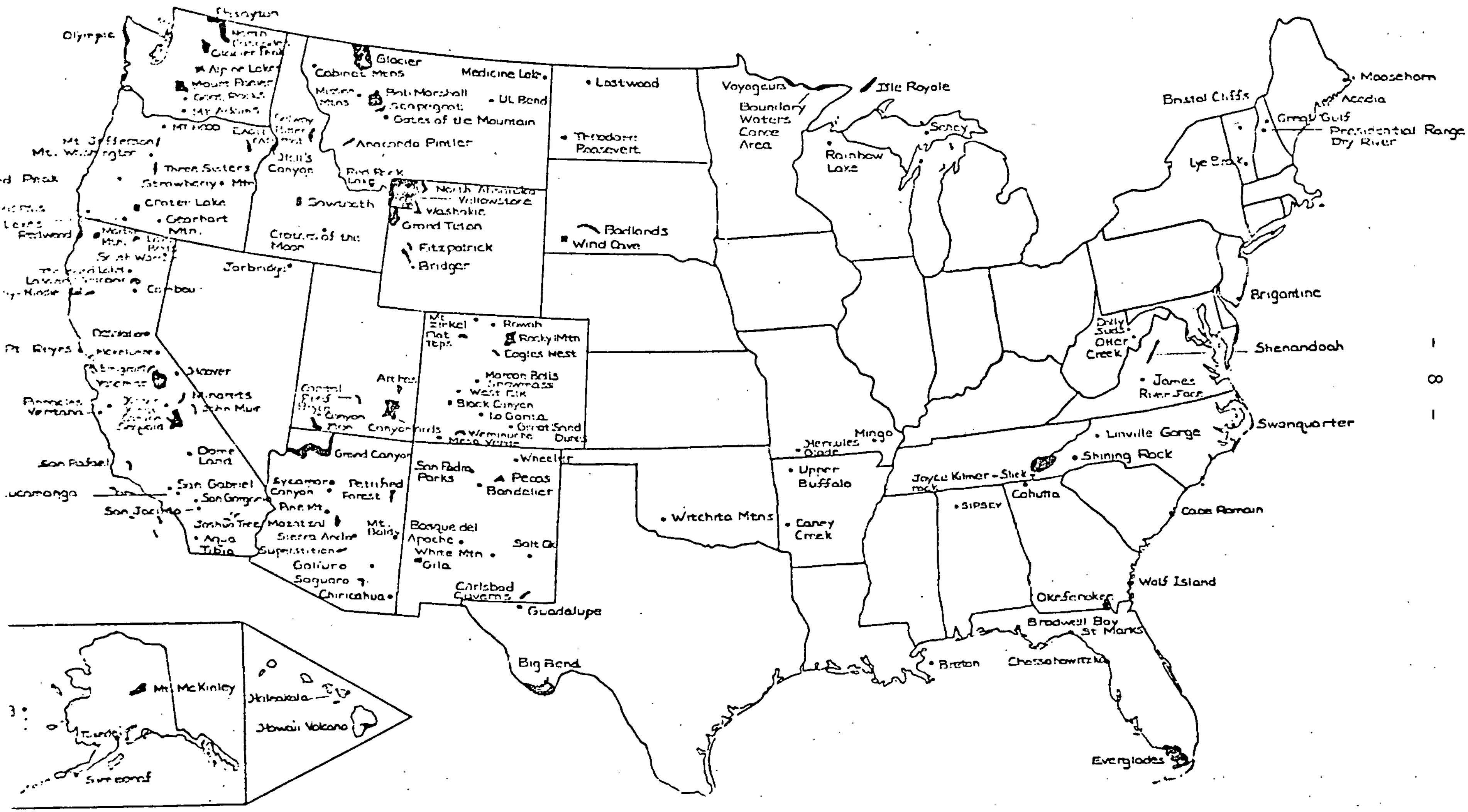
**National Memorial Parks**

*North Dakota* — Theodore Roosevelt National Memorial Park, 70,408 acres.

*Environment Reporter, Current Developments, Bureau of National Affairs, Washington, D.C., Vol. 8, #16, August 19, 1978, p. 588.

FIGURE 1

MANDATORY CLASS I AREAS




Prepared by USEPA,
Office of Air Quality Planning and Standards,
Research Triangle Park, North Carolina.

TABLE 2

INCREMENTS AND CEILINGS

Pollutants (in micrograms per cubic meter)

| | Total Suspended Particulates | | Sulfur Dioxide | | |
|---|---|---|---|---|---|
| | Annual | 24-hr | Annual | 24-hr | 3-hr |
| Class I | 5 | 10 | 2 | 5 | 25 |
| Class I "relief" | 19 | 37 | 20 | 91 | 325 |
| Class I 18-day variance: | | | | | |
| low terrain | - | - | - | 36 | 130 |
| high terrain | - | - | - | 62 | 221 |
| Class II | 19 | 37 | 20 | 91 | 512 |
| Class III | 37 | 75 | 40 | 182 | 700 |
| NAAQS | | | | | |
| Primary | 75 | 260 | 80 | 365 | * |
| Secondary | 60 | 150 | * | * | 1300 |

* Value not specified

Areas not included in the above list or the list of mandatory Class I areas may be redesignated by a state as Class III. This redesignation procedure requires public hearings as well as input and, in some cases, approval from the Governor of the State, local governments, the Federal Land Manager, EPA, and Indian tribes affected.

*Section 165: Preconstruction Requirements*

*Proposed new sources or major modifications will be reviewed for projected emissions.*

Construction of a new major emitting facility may take place only if the owner or operator has been issued a valid permit; has demonstrated that emissions from the facility will not violate PSD increments, NAAQS, or other applicable emission standards; will use best available control technology on the source; and has agreed to conduct the necessary analysis and monitoring of emissions. EPA must approve the determination of best available control technology in the case of a source proposing to construct in a Class III area if it might cause the increment in an adjacent Class II area to be exceeded. A permit may be issued for a source even though the maximum allowable increases over baseline concentrations in an adjacent Class I area are thereby exceeded, but provided that the increases listed in Table 2 as Class I "relief" levels are not exceeded.

*Emissions must not violate appropriate increments, except for certain waivers for Class I areas.*

A variance from compliance with $SO_2$ increments of 24 hours or less may be granted by a state to allow for construction of a new major emitting facility in a Class I area. This may only be done after public hearing and with the concurrence of the Federal Land Manager. If the recommendations of the State Governor and the Federal Land Manager disagree, the President shall approve or disapprove the variance. If a permit is issued under this variance, the increases listed in Table 2 will be allowed for not more than 18 days during any annual period. On the remaining days, the Class I increments will apply.

*Air quality monitoring will be required.*

For review of a permit application, the state, EPA, the Federal Land Manager, the owner, or the Governor of an adjacent state may all cite the potential effects of the new facility as input to the application process. EPA is required to promulgate regulations concerning new source permit review and the analysis and air quality monitoring required. The air quality data must be gathered over a one-year period, unless a shorter period is deemed adequate by EPA, and shall be available at the public hearing on the permit application. In its regulations concerning the required analysis, EPA shall not require the use of buffer zones; shall require analysis of ambient air quality, climate and meteorology, terrain, soils, vegetation, and visibility at the proposed site; shall require the results of the analysis to be available at the public hearing; and shall specify the air quality models to be used.

*Section 166:Other Pollutants*

*EPA is to extend PSD to other pollutants.*

EPA shall study and promulgate within two years PSD regulations for hydrocarbons, carbon monoxide, photochemical oxidants, and nitrogen oxides. When NAAQS are set for new pollutants, EPA shall follow up with PSD regulations within two years. These regulations will become effective one year after promulgation. An area classification plan shall not be required for these other pollutants.

*Section 167:Enforcement*

EPA shall -- and a state may -- issue an order or seek injunctive relief to prevent construction of a new source which does not conform to PSD requirements.

*Section 168:Period before Plan Approval*

Until new implementation plans come into effect, existing PSD regulations shall remain in effect. Existing regulations inconsistent with this new PSD legislation shall be deemed amended to conform with it.

*Section 169:Definitions*

*What sources will be reviewed?*

The term "major emitting facility" means any of twenty-eight specified categories of new sources which have the potential to emit more than 100 tons per year of any air pollutant (see Table 3). The term also includes any source with the potential to emit more than 250 tons per year of any air pollutant.

*What is BACT?*

The term "best available control technology" means an emission limitation, determined by the permitting authority, capable of achieving the maximum reduction of pollutants, taking into account energy, environmental, and economic impacts and other costs. It is to be determined on a case-by-case basis and to include fuel cleaning or treatment and innovative fuel combustion techniques. In no case shall the use of BACT result in emissions that exceed New Source Performance Standards or National Emission Standards for Hazardous Pollutants.

*How is baseline air concentration defined?*

The term "baseline concentration" means the ambient concentration level existing at the time of the first permit application in the area, based on EPA air quality data and the monitoring data required from the applicant. The baseline will include projected emissions from facilities on which construction commenced before January 6, 1975, but which were not in operation at the time of the first permit application.

EPA is to give guidance to the states on control strategies for pollutants other than sulfur oxides and particulates -- primarily, photochemical oxidants.

*Section 169A:Visibility Protection for Federal Class I areas*

The prevention of impairment of visibility in Class I areas is declared to be a national goal. The Secretary of the Interior is to review all mandatory Class I areas where visibility is important, and EPA is to promulgate a list of such areas within

TABLE 3

MAJOR EMITTING FACILITIES

Fossil-fuel fired steam electric plants of more than two hundred and fifty million British thermal units per hour heat input

Coal cleaning plants (thermal dryers)

Kraft pulp mills

Portland Cement plants

Primary zinc smelters

Iron and steel mill plants

Primary aluminum ore reduction plants

Primary copper smelters

Municipal incinerators capable of charging more than two hundred and fifty tons of refuse per day

Hydrofluoric, sulfuric, and nitric acid plants

Petroleum refineries

Lime plants

Phosphate rock processing plants

Coke oven batteries

Sulfur recovery plants

Carbon black plants (furnace process)

Primary lead smelters

Fuel conversion plants

Sintering plants

Secondary metal production facilities

Chemical process plants

Fossil-fuel boilers of more than two hundred and fifty million British thermal units per hour heat input

Petroleum storage and transfer facilities with a capacity exceeding three hundred thousand barrels

Taconite ore processing facilities

Glass fiber processing plants

Charcoal production facilities.

*Visibility protection in Class I areas is a national goal.*

one year. Within eighteen months EPA shall study and report on the identification, quantification, measurement, and modeling techniques required to implement this national goal. Sources and pollutants will also be identified. Then, within two years, EPA shall promulgate regulations aimed at achieving this goal. These regulations will provide guidelines to states in drawing up implementation plans. Specifically, major sources less than fifteen years old that contribute to visibility deterioration will be required to install best available retrofit technology as expeditiously as possible, but in any event within five years. EPA may consider exempting a major source from compliance, except any fossil-fuel fired power plant with design capacity of more than 750 megawatts, which may be exempted only if the owner or operator demonstrates that the proposed plant alone or in combination with other sources will not impair visibility in clean areas.

EPA shall not require the use of automatic or uniform buffer zones. In determining best available retrofit technology, considerations required for BACT apply; also required to be taken into consideration are existing control technology, the degree of improvement in visibility which may be expected,and any nonair quality environmental impact. The sources to which this section applies are those twenty-eight source categories listed for PSD with the potential to emit more than 250 tons. Reduction in visual range and atmospheric discoloration are included in the term "visibility impairment."

# III. BACKGROUND

## HISTORY OF LEGISLATION

### *Clean Air Act*

*The Clean Air Act and subsequent Amendments established air quality goals.*

The Clean Air Act Amendments of 1970 were the culmination of previous legislation that included the 1955 Air Pollution Control Act, the 1963 Clean Air Act, major amendments in 1965 and 1967, and the Air Quality Act of 1967. Although the 1977 Amendments have considerably modified them, the Clean Air Act Amendments of 1970 provide the primary enabling legislation for air quality management in the United States today. One of the fundamental purposes of these Amendments, and one which was later to be the subject of controversy, was "to protect and enhance the quality of the Nation's air resources so as to promote the public health and welfare and the productive capacity of its population."[9] The words "protect and enhance the quality of" had been inserted by the Air Quality Act of 1967, without an explanation of the purpose or possible implementation of the objective. The Environmental Protection Agency (EPA) was given major administrative responsibility for the Clean Air Act Amendments of 1970.

### *EPA Action*

*EPA set National Ambient Air Quality Standards.*

Under the provisions of the Act, EPA promulgated National Ambient Air Quality Standards (NAAQS) to protect public health and welfare (4/71). EPA followed up by publishing guidelines to assist states in the adoption of air quality standards (8/71). Each state was required to submit a State Implementation Plan (SIP) to achieve and maintain the primary NAAQS by July, 1975,and the secondary within a reasonable time.

### *Sierra Club Suit*

Initially, the issue of protecting air quality in areas where the ambient air quality was already better than the level required by the NAAQS was not addressed. The Sierra Club and other environmental groups claimed that the EPA recommendations permitted air quality in these clean areas to deteriorate to the level of the appropriate NAAQS, and that this was in conflict with the stated aim of the Amendments "to protect and enhance the quality of the Nation's air resources."

*Environmentalists sued EPA for failing to prevent significant deterioration.*

Suit was filed[10] in the District Court for the District of Columbia (5/72) by the Sierra Club seeking a declaratory judgment and an injunction requiring EPA to disapprove any SIP that permitted "significant deterioration" of air quality. The District Court ruled for the Sierra Club (5/72) in a preliminary hearing, and this judgment was subsequently affirmed by the Court of Appeals for the District of Columbia (11/72) and by the Supreme Court on a 4-4 vote (6/73). EPA was, therefore, directed to review all SIPs and disallow any that did not adequately provide for protection of clean air areas, and to promulgate regulations to prevent significant deterioration of air quality in these areas.

*EPA Regulations*

*EPA published PSD regulations in 1974.*

EPA considered various alternative plans for the prevention of significant deterioration of air quality and conducted public hearings on their preliminary proposals. The proposals immediately drew criticism from concerned factions. Environmental groups claimed that the regulations were deficient because they considered only two of the six pollutants regulated by the NAAQS and because they would still permit deterioration to the level of the NAAQS in some areas. Industries viewed the PSD regulations as tantamount to a "no-growth policy," in that industrial development in many areas of the nation would be severely inhibited by the stringent controls. State authorities maintained that the regulations represented interference in local land-use decisions.

EPA finally published PSD regulations[11] (12/74) eighteen months after the Supreme Court decision, with further amendments in 6/75.

The regulations, restricted to areas that were already cleaner than required by the NAAQS, established three classes of areas in which specified increases in air pollutant concentration ("increments") would be allowed:

*A three-tiered area classification scheme was set.*

Class I -- where any deterioration would be deemed significant and only very small increments would be permitted. These are termed "pristine areas".

Class II -- where moderate increments would be permitted in accordance with moderate industrial growth.

Class III -- where the maximum increments would be permitted to allow for major industrial expansion. Class III concentrations would be allowed to increase to the appropriate secondary NAAQS.

New major facilities within 19 source categories would be required to undergo a preconstruction review to determine projected emission levels.

EPA initially designated all areas of the nation as Class II, allowing states to redesignate areas either as Class I or Class III, and the Federal Land Manager to redesignate Federal lands under his jurisdiction as Class I. This scheme is in contrast to the more restrictive Congressional version establishing mandatory Class I areas.

*Allowable increments in air pollution for sulfur dioxide and particulate matter were established.*

The EPA regulations considered only two of the six NAAQS pollutants -- sulfur dioxide and particulates. The maximum increases in pollutant concentration that would be allowed were specified in "increments," measured in micrograms per cubic meter, over a "baseline concentration." These regulations were subsequently upheld by the Circuit Court of Appeals for the District of Columbia (8/76) following challenges by a group of utilities and industrial organizations and by environmental organizations.

*Legislative Action (94th Congress)*

*Congress introduced PSD legislation in 1975...*

EPA ran into numerous difficulties in implementing the PSD regulations. To obtain a firmer legal base, the Agency asked Congress to provide explicit guidance. The 94th Congress began consideration of amendments to the Clean Air Act that specifically addressed the PSD issue (10/75).

In the House, the Clean Air Act Amendments Bill, H.R. 10498, was reported by the Committee on Interstate and Foreign Commerce (5/76) and passed (9/76). In the Senate, a similar bill, S. 3219, was reported by the Committee on Public Works (3/76) and subsequently passed (8/76). Both bills had come under sharp criticism on the floors of the House and Senate but were passed with only minor changes.

The Congressional proposals for PSD retained the area classifications of the EPA regulations; moreover, they required mandatory establishment of clean air areas in which only small increments of pollutant concentration would be permitted. Both proposals gave states greater control over the classification of areas. While it seemed that industry could meet the requirements of either bill, the Senate version was considered to be more flexible.

*...but no bill was passed.*

A compromise Conference Report retaining selected aspects of the House and Senate Bills was drafted and reported (9/76). The Conference Bill came back to the House and Senate in the last few days of the session but was obstructed by a filibuster in the Senate. As a result, no bill was presented to the President for signature.

*Legislative Action (95th Congress)*

The amendments were reintroduced in the 95th Congress. In the House, Clean Air Act Amendment, H.R. 4151, was introduced (2/77) to supersede H.R. 10498. In the Senate, similar bills, S. 252

*Clean Air Act Amendments, including PSD provisions, were passed August, 1977.*

and S. 253, were introduced (1/77) to supersede S. 3219 and the Conference Bill, respectively. These three new bills contained no substantive changes from the earlier bills in regard to PSD requirements. After committee hearings, the House passed its bill (5/25/77) with an amendment that would allow an 18-day-per-year exemption from PSD provisions (the Breaux Amendment). A similar amendment was rejected when the Senate Bill passed (6/10/77). When H.R. 6161 was reported out of conference (8/3/77) it contained a modified version of the House exemption provision. Considerable pressure existed at this time to pass the amendments before the August recess. H.R. 6161 passed the House and Senate the same week and was signed into law by President Carter (8/7/77) as Public Law 95-95.

## EPA ENFORCEMENT

*EPA's schedule for implementing PSD.*

EPA is on the following mandated schedule for implementation of the PSD amendments:

| Time Frame* | Task |
|---|---|
| Immediately | • Amend PSD regulations to reflect new increments, area classifications, control technology requirements, and preconstruction review.<br>• Begin a study of all pollutants regulated by the Act for BACT purposes. |
| Six months | • Promulgate regulations concerning information on new sources in Class III areas.<br>• Promulgate regulations establishing requirements for the air quality analyses. |
| One year | • Report on the definition of a "major emitting facility."<br>• Report on the status of PSD for other pollutants and on control technology for oxidants.<br>• List visibility protection areas. |

* With respect to August 7, 1977, the date of enactment of PL 95-95.

| Time Frame* | Task |
|---|---|
| 18 months | • Report on methods to protect and improve visibility in Class I areas. |
| Two years | • Promulgate PSD regulations for other pollutants. |
| | • Report on and recommend PSD regulations for oxidant control. |
| | • Promulgate regulations for visibility protection. |

*Immediate Regulatory Changes*

*On November 3, EPA made changes in existing PSD regulations...*

In an October 6 memo,[12] EPA announced that all PSD provisions of the Clean Air Act Amendments (CAAA) of 1977 were to be implemented as of the date of enactment of the law, August 7, 1977. Controversy immediately arose over the possible delays for proposed major sources which had already initiated PSD permits under existing regulations. DoE, for example, argued that the construction of 7,000 to 21,000 MW of new baseload power plants could be delayed by 12-18 months. Others argued that the delays would be more of the order of six weeks to three months. EPA reversed its earlier ruling and announced that the existing PSD regulations, with only a few changes, would be in effect until March 1, 1978 at which time new regulations reflecting the CAAA of 1977 would be promulgated.

*...and proposed additional revisions, to be made final in March.*

On November 3, EPA published three items in the Federal Register:[13] (i) immediately-effective changes in PSD regulations: (ii) proposed revisions to the regulations, to be promulgated March 1, 1978; and (iii) proposed guidelines to the states for revising State Implementation Plans to prevent significant deterioration of air quality. Final guidelines are to be promulgated March 1, 1978, requiring revised SIPs to be submitted nine months later, or by December 1, 1978.

EPA regulations will remain in effect until states submit revised SIPs that are accepted by EPA. The proposed rule-making does not make any explicit provisions for EPA regulations to be in effect beyond December 1, in the event that states have not submitted approved SIPs by that date.

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* With respect to August 7, 1977

The immediate changes in EPA regulations cover:

*What are the immediately-effective changes?*

- the new increment levels of the CAAA of 1977,
- new mandatory Class I areas,
- a revised definition of baseline concentration,
- a more explicit definition of "commencement of construction",
- new redesignation procedures for Class III areas,
- a clarification of the stack heights to be credited in modeling emissions from new sources.

*How is commencement of construction defined?*

Construction will be considered to have commenced if all the relevant permits have been granted <u>and</u> either continuous physical on-site construction has begun or binding agreements have been made for construction that cannot be cancelled without substantial loss to the owner of the proposed facility. EPA has proposed that "substantial" be defined as a loss of more than 10% of the total project cost.

*Stack height credit will be limited.*

Stack height is to be limited to good engineering practice, or that height which is necessary to avoid atmospheric downwash, wakes and eddies, and is generally defined as no more than 2 1/2 times the height of the source. EPA has noted that previously-granted PSD permits must be reviewed for stack height credit and, if increments would have been violated if all sources had been limited to the new rule on stack heights, no new source will be allowed to locate in the area. Sources which had received PSD permits but had not commenced construction before August 7, 1977, will be reexamined for compliance with the increment ceiling under such stack-height limitations.

EPA has announced that, in the interim before March 1, the following regulations on PSD permits will apply:

- If a source received a PSD permit but did not commence construction (under the new definition) before August 7, 1977, the permit must be reviewed in light of the immediately effective rules.

*EPA clarified the review procedures for new sources in the interim before March.*

- Although BACT would not be required for the proposed new source, the source must be reexamined for compliance with the new increment ceilings, the stack-height limitations, and the new mandatory Class I areas. If violations of the regulations are determined, the permit would be revoked.

- If a source is granted a PSD permit to construct before March 1 and commences construction before December 1, no further PSD review will be required. In particular, for sources which were not included in EPA's 19 categories subject to new source review for PSD, but are included in the 28 categories identified in the proposed rules to be effective March 1, no review for PSD will be required, if all relevant permits are received before March 1 and if construction commences before December 1.

- To forestall any rush to initiate and complete permit applications, EPA has announced that major new sources should anticipate at least 90 days between application and approval. Therefore, unless a permit application was submitted before December 1, 1977, a new source could not expect approval before the new regulations become effective on March 1, 1978.

- Federal Land Managers should also be aware that a class redesignation application under existing EPA regulations (including the immediately-effective provisions) would not be acted upon before March 1, when new regulations will withdraw their authority to request such redesignation.

*Proposed Rules*

The EPA proposed rule-making contains many provisions that are explicitly required by the legislation. However, the law also contains a number of areas open to administrative interpretation by EPA. For example, the Agency intends to require PSD permits

*Many areas of PSD implementation are open to EPA interpretation.*

in all areas of the country, not just clean-air regions, since long-range transport of pollutants could violate allowable increments in adjacent PSD areas. EPA has also determined that the legislation requires a preconstruction review to ensure that a new source will employ the best available control technology (BACT) for all pollutants covered in the Act (all six of the NAAQS criteria pollutants -- hydrocarbons, carbon monoxide, oxidants, nitrogen oxides, as well as the two pollutants specifically covered by allowable increments, sulfur dioxide and particulates; those pollutants regulated under National Emission Standards for Hazardous Air Pollutants; and pollutants regulated for mobile sources). The BACT review will be required for all sources with the potential to emit more than 100 tons of any pollutant per year. The issues associated with these and other areas of administrative discretion are discussed in Chapter IV, Implementation.

## RELATED AIR QUALITY LEGISLATION

*What else is in the Clean Air Act and Amendments?*

EPA was charged under the Clean Air Act Amendments of 1970 with the responsibility for establishing standards for control of both ambient air quality and pollutant emissions from stationary sources. In response, EPA promulgated National Ambient Air Quality Standards (NAAQS) and New Source Performance Standards (NSPS). Regulation of sources in areas already in violation of NAAQS (so-called non-attainment areas) was also required. Like PSD these other provisions of the Amendments will have a major effect on facility siting and the costs of power generation. All require certain levels of performance or emission limitations and are applicable to certain sources or regions or pollutants. In some circumstances, PSD may be the determining standard; in others it might be nonattainment.

*National Ambient Air Quality Standards (NAAQS)*

*NAAQS were established to protect health and welfare.*

NAAQS were subdivided into primary standards, designed to protect health, and secondary standards, designed to protect public welfare (damage to materials, vegetation, etc.). These ambient standards specify the permissible concentrations of pollutants at ground level for various time periods. EPA intended that all averages for less than one year were not to be exceeded more than once per year. The continental United States was divided into 243 Air Quality Control Regions (AQCR's) for the purpose of implementing NAAQS. Six pollutants were regulated in the NAAQS: total suspended particulates, sulfur dioxide, nitrogen oxides, carbon monoxide, hydrocarbons, and oxidants. States had the option of adopting more stringent air quality standards of their own in the State Implementation Plans (SIP's) which some did.

*The 1977 Amendments require EPA to review and revise NAAQS, and possibly set standards for new pollutants.*

The Clean Air Act Amendments of 1977 require EPA to review the NAAQS before 1981 and at five-year intervals thereafter and to revise them if appropriate. A seven-member committee appointed by EPA is to review criteria for NAAQS on the same schedule. The current standards have been criticized as inadequate to protect health in terms of the level set, the invalidity of a threshold concept (i.e., a level below which no adverse health effects occur), and the possible adverse effects of long-term, low-dose exposure to pollutants. The standards have also been criticized as more stringent than research evidence would justify. If revisions in the NAAQS require more stringent levels, available increments will be reduced because the NAAQS are the upper limit for the allowable increments (primary or secondary, whichever are lower) in Class III areas. The legislation also requires EPA to study a number of other pollutants (radioactive emissions, cadmium, arsenic, polycyclic organic matter, and sulfates) for possible regulation if they are determined to have adverse health effects. If ambient air standards are established for additional pollutants, emission limitations would need to be set and PSD regulations extended.

*New Source Performance Standards (NSPS)*

*EPA set New Source Performance Standards.*

The Clean Air Act of 1970 required EPA to publish lists of major stationary sources and promulgate regulations to establish appropriate emission limitations. NSPS for fossil-fuel fired boilers of heat input greater than 250 million Btu per hour were promulgated by EPA in 1971. These standards cover major utility sources, and several standards for industrial sources were promulgated in the following years. Many states also elected to adopt more stringent emission standards than NSPS requirements in their SIPs.

*The 1977 Amendments require revisions in the NSPS.*

The Clean Air Act Amendments of 1977 call for a revision in the existing NSPS. Sources are to achieve a percentage reduction in emissions, in addition to an emission limitation, and to use the "best technological system of continuous emission reduction".[14] Some confusion has arisen over how this definition of control technology differs from the "best available control technology" (BACT) required in a PSD preconstruction review. The complicated legislative history of the amendments may account for the possible inconsistencies of PSD and NSPS sections of the Act as finally passed. The original House Bill (HR 6161) introduced continuous emission control under NSPS, while the Senate Bill (S. 252) required BACT in a PSD review but did not include requirements to revise NSPS. The Conference Report combined the two bills in an effort to achieve agreement for final passage before a recess deadline, without addressing the possible inconsistencies.

*What is the relationship between the emission limitation required by BACT and by NSPS?*

The relationship between the two definitions of control technology requirements will become clearer as EPA and the states administer the Act. BACT could be more stringent than the emission limitation set for a category of sources under NSPS, since it is to be set on a case-by-case basis. Specific conditions for each site, such as fuel-type, meteorology, and terrain, are to be considered in the determination of BACT; in addition, a case-by-case review procedure could reflect the latest developments in control technology.

*What are the probable NSPS for steam generators?*

Revised and more stringent NSPS for large steam generators are to be promulgated by EPA early in 1978 and can be expected to have considerable impact on coal production and the development of new technologies. Existing and probable NSPS for sulfur dioxide and particulate emissions from large steam generators using solid fuel are:

| | NSPS | |
|---|---|---|
| | Existing | Probable |
| Total Suspended Particulates | | |
| absolute limitation | 0.1 lb/mmBtu | 0.03 lb/mmBtu |
| percentage reduction | - | 99% |
| Sulfur Dioxide | | |
| absolute limitation | 1.2 lbs/mmBtu | 1.2 lbs/mmBtu |
| percentage reduction | - | 90% |
| maximum control | - | 0.2 lb/mmBtu |

For sulfur dioxide, the existing upper limit of 1.2 lbs/mmBtu remains, and uncontrolled emissions would have to be reduced by 90 percent. The percentage reduction would not apply, however, if emissions are less than 0.2 lb/mmBtu.

*Non-attainment Areas*

*The 1977 Amendments address growth in non-attainment areas.*

Areas exceeding a particular NAAQS are termed non-attainment areas, for which new regulations for industrial and urban development were established by the 1977 amendments.[15]

Prior to July 1, 1979, a state may approve construction of a new major source in a non-attainment area either by using EPA emission offset policy (which requires pollution increases from a new major source to be more than offset by decreases from existing sources) or by granting a waiver.

*Emission-offset and LAER will be required.*

After July 1, 1979, a state must have an approved, revised SIP as a precondition for permitting the construction of new major sources. The plan must (i) include a comprehensive inventory of emissions from all sources; (ii) require permits for construction of new major sources; (iii) provide for implementation of reasonably available control measures; and (iv) require reasonable further progress towards achieving standards (reasonable progress being defined as equal, incremental reductions in emissions every two years).

An applicant wishing to site a new source in a non-attainment area is required to use LAER (the lowest achievable emission rate), defined as the most stringent emission limitation in any state for the category of sources or the most stringent level achievable in practice, whichever is more stringent.

## IV. ISSUES RELATED TO PSD

*What are some of the issues related to PSD?*

Several issues have arisen in connection with PSD that have implications for the scope, impact and future course of the regulations. The protection of health from the adverse effects of air pollutants is a primary reason for air quality regulations. However, considerable uncertainty surrounds the extent of those adverse effects and the specific pollutants and concentration levels detrimental to health. Is this uncertainty a major justification for PSD? Are the present NAAQS adequate to protect health? If the NAAQS are not adequate, should the regulatory mechanism be a revision of the existing standards rather than PSD?

The protection of public welfare, including visibility and other esthetic values, has been described as one of the most important justifications for PSD. Will the desire to protect visibility seriously constrain energy growth in the West and Southwest? The emission limitations required by a BACT review will be based on the permitting authority's judgment of the capabilities of control technology. What is the current status of emission abatement strategies? What areas of control technology are in most need of improvement? Finally, although PSD now exists as law, the implementation of the provisions rests with EPA. EPA has issued proposed rules for new regulations, in many cases exercising judgment on administrative feasibility and Congressional intent. EPA enforcement procedures, together with subsequent court decisions, will largely determine the scope and impact of PSD.

### HEALTH

The adverse impacts of airborne pollutants on health and welfare form the basic rationale for the establishment of air quality standards to control the emissions of such pollutants. In the report prepared by the House Committee on Interstate and Foreign Commerce (to accompany HR 6161) it was stated:

*Is PSD intended to protect health?*

> There can be no question that the national ambient air quality standards are necessary and beneficial for protection of the healthy and reduction of risk to the susceptible and chronically ill. However, it is also clear that a combination of ambient standards with a policy for prevention of significant deterioration of air quality is necessary to provide for maximum feasible protection of the public health.
>
> ...in the committee's view, the need to prevent significant deterioration in so-called clean air areas arises in substantial part from the need to protect the public's health.[16]

These statements have been disputed by opponents of PSD. The Senate debate on the PSD Section of H.R. 6161 included the following statements:

*Or are the NAAQS adequate for such protection?*

> Of course, at no time could the primary and secondary ambient air quality standards be violated, so there is no question of health or welfare effects....We are only talking about nondeterioration, and nondeterioration is not concerned with health, it is concerned with esthetics....[17]

However, the House committee, noting the growing uncertainty over the health effects of airborne pollutants and over the adequacy of present regulations, concluded that any legislation that helps to reduce overall emissions is helping to protect health:

*Uncertain health effects of air pollutants may be a reason for PSD.*

> Since 1971 when the national ambient air quality standards were set, new and disturbing information has come to light showing that the public's health is being harmed to some extent, perhaps seriously, even at levels below the national standards...[18]
>
> Since there is a reasonable basis for anticipation of tightening of the ambient standards, a policy of maximum practicable protection of health has been developed.[19]

This is echoed in Section 160 of the 1977 Amendments as the first purpose of PSD:

> To protect public health...from any actual or potential adverse effect...notwithstanding attainment and maintenance of all national ambient air quality standards.

*EPA will be revising NAAQS.*

The issue thus arises of whether existing and proposed standards do adequately protect public health. The existing NAAQS have been criticized both as being inadequate to protect health and as more stringent than air quality criteria would justify. EPA is required by the Clean Air Act Amendments of 1977 to review the existing standards and to revise them, if necessary. The EPA schedule for revisions is as follows: oxidants -- March, 1978; nitrogen oxides -- January, 1979; carbon monoxide -- December, 1979; sulfur dioxide and suspended particulates -- May 1980; and hydrocarbons -- September, 1980.[20] If the existing NAAQS are subsequently determined to have been inadequate to protect health, PSD would have provided a margin of safety in clean air areas, forestalling the need for additional enforcement action later.

*Adverse Health Effects*

Harmful effects of air pollutants that have been identified thus far include:

*What are some adverse health effects of air pollutants?*

(i) Irritation. Symptoms of inflammatory irritation include sore throat, coughing and vasoconstriction. Primary irritants are $SO_2$, $NO_2$, their acid aerosols, and certain organics.

(ii) Respiratory disease. Incidence of acute respiratory disease (asthma, influenza, pneumonia, etc.) is increased by continued exposure to irritants. Chronic respiratory disease (bronchitis and emphysema) can develop from prolonged exposure. Pneumoconioses can develop from respiration of certain kinds of irritant particles (coal dust, silicon, asbestos, etc.).

(iii) Direct toxicity. Carbon monoxide acts primarily by toxic absorption into the hemoglobin of blood. This can worsen symptoms of heart disease, as well as asphyxiate. Accumulation of trace metals (lead, mercury, etc.) in body organs also leads to toxic action.

(iv) Carcinogenesis. Nitrogen oxides in the presence of certain organic bases can form the class of highly-potent carcinogens called the nitrosamines. Direct acting carcinogens (polycyclic organic hydrocarbons) can be absorbed via particulate carriers. Although present information is not adequate to link air pollution with the increased incidence of cancer in the last forty years, the Department of Health, Education and Welfare[21] believes that cancer is now generally recognized as being 70% to 90% environmental in origin (this includes cigarette smoking).

(v) Genetic effects. Gene mutations are known to be caused by ozone and by the carcinogens mentioned above. It is unlikely, however, that conclusive proof of the carcinogenic or mutagenic potential of air pollution will be arrived at in the near future.

*Criticism of Standards*

*The existing standards have been criticized.*

Criticisms of NAAQS and EPA PSD regulations that have been made over the last few years can still be leveled against the Clean Air Act as amended in 1977, which has not considered them in any detail. Consideration of these criticisms is important, for they may indicate the path that future regulations and legislation will take. The major health-based criticisms are:

*Safety margins may be inadequate.*

(i) The safety margins established in the NAAQS and PSD regulations are inadequate. Not only are the safety margins for airborne pollutants smaller than similar levels established for pesticides and radiation hazards, but the very concept of an absolute safety margin is itself invalid. This so-called "no-effects threshold," below which no harm is done, is probably a false concept. Any level of pollutant produces some deleterious health effect, and the potential for harm is found to exist at increasingly lower levels of concentration as research advances.

Research[22] has shown that deaths are occurring at levels not far above the present 24-hour $SO_2$ level and that the present $NO_2$ and carbon monoxide standards ignore specific health dangers to angina patients.

(ii) The regulations are designed with short-term health effects in mind (irritation, respiratory ailments, etc.). They are not designed to protect against cancer, genetic mutations, or birth defects, which may be associated with the long-term, low-dose effects of air pollution.

*Fine particulates may be particularly dangerous.*

(iii) Fine particulates may be more hazardous than was realized in the establishment of regulations for other suspended particulates. Inhaled large particles are efficiently filtered out in the nasopharengeal and tracheobronchial regions, and they can be rapidly eliminated. Smaller particles tend to pass into the lower respiratory areas, where they can remain for months or even years. This greatly increases the health danger, because fine particles can also "carry" other hazardous combustion products (trace metals, hydrocarbons, organics) by adsorption, leading to accumulation problems.

(iv) The dangers from $SO_2$ and $NO_2$ may be of less significance than from sulfuric and nitric acid aerosols that may be formed in the atmosphere in the presence of water vapor. These aerosols are subsequently converted to sulfates and nitrates. The health and environmental effects of these aerosols may be potentially more harmful than those of the original gases.

*Synergistic effects are not considered.*

(v) Current regulations do not consider synergistic effects -- effects resulting from interactions among different pollutants in the atmosphere. Potential dangers have been shown to arise from combinations of $SO_2$ and water, $NO_2$ and particulates, $SO_2$ and $NO_2$ and particulates, $SO_2$ and ozone, and ozone and radiation, which are greater than from the individual species alone.

(vi) Ambient air regulations assume that the pollutant effect is limited to the vicinity of the source. The PSD amendments do include special instructions for cross-boundary effects between a source in one area and related pollutant concentrations in an adjacent area. However, new data have revealed that fine particulates and aerosols can be transported several hundreds of miles under certain atmospheric conditions.

*Existing research data have been criticized.*

(vii) Much of the data linking health effects to air pollution originated in EPA's Community Health and Environmental Surveillance System (CHESS) studies,[23] which have been strongly criticized in the last three years. Current consensus seems to be that the CHESS studies suffered from overinterpretation of data, inadequate or incomplete statistical analysis, and inaccurate presentation of results. Although the CHESS data were not the basis for the initial setting of NAAQS, they have been frequently referred to as supportive of the standards and of regulatory action.

*Need for Research*

*Information is needed on health effects of all energy technologies.*

More information is clearly needed on the adverse health effects of emissions from all energy technologies. In a recent report, the National Academy of Sciences, for example, noted the "lack of reliable data on exposures of the total U.S. population to pollutants..." and the "...inadequate information on the cumulative effects on health attributable to these exposures," concluding

> we are unable to derive firm estimates of the total risk to the health of the general community created by the fossil fuel energy systems. It is clear, nonetheless, that this burden on our health is large and widespread.[24]

Although research is being conducted on the health effects of emissions from developing energy technologies, the Department of Health and Welfare has noted that "the study of developing technologies posed considerably more problems than the study of existing industries,"[25] since some characteristics of processes might alter from pilot plant to commercial plant. The basis for political decisions on the balance between energy development and the protection of health would be greatly improved by more information on the adverse health effects of airborne pollutants.

## WELFARE, INCLUDING VISIBILITY

*The NAAQS are intended to protect welfare.*

Public welfare was defined in the Clean Air Act Amendments of 1970 as including "effects on soils, water, crops, vegetation, man-made materials, animals, wildlife, weather, visibility and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being."[26] The secondary NAAQS were designed to be adequate to protect public welfare. However, one of the stated purposes of PSD was to protect both health and public welfare from adverse effects of air pollution, over and above the protection provided by the NAAQS. Although adverse effects of air pollutants on agriculture, materials, and the natural environment (plant, animal, soil, water, climate, etc.) have been identified, the effects caused by pollution levels exceeding present standards are rarely separated from those caused by concentrations less than the standards. A brief summary of adverse effects of air pollution on welfare follows.

### *Agriculture*

*What are some harmful effects of air pollution on welfare?*

Adverse effects of air pollution on agriculture and plants include a reduction in both the quantity of output and the quality of the product. Sulfur dioxide, oxidants, nitrogen oxides, acid rain and fluorides have been identified as the principal pollutants responsible for damage to vegetation. Acid rainfall can seriously stunt plant growth or damage foliage. Synergistic effects of sulfur dioxide and ozone are particularly harmful. In addition, there is a complex relationship between air pollution, plant disease, pests and crop damage which is little understood, but the situation appears to be worsened by higher levels of pollution.

*Vegetation is harmed by $SO_2$.*

Studies of the effects of sulfur dioxide on vegetation indicate a great variation in plant responses to the pollutant as a result of the differences in species, the stage of growth, climatic factors (such as temperature and humidity), the time of day of exposure, and soil moisture and acidity. The House Committee[27] collected data on seventeen different crops, including barley, oats, soybeans and potatoes, showing leaf necrosis or decrease in yield at $SO_2$ levels below the secondary NAAQS.

Several estimates of the cost of agricultural damage due to air pollution have been made. The Department of Agriculture, for example, estimated the annual crop damage from air pollutants as $500 million, largely from sulfur dioxide and ozone.[28] This estimate, however, covers damage from total pollution levels, without distinguishing between the effects from pollution above or below the national standards. A study conducted at the Stanford Research Institute[29] estimated the national total damage in the form of visible injury to vegetation to be $132 million each year. This estimate did not include the subtle effects of air pollution which are not visible but may be identified when physiological change occurs in the plant.

*Natural Environment*

*$SO_2$ adversely affects plants and animals.*

Sulfur dioxide in the gaseous and acid-rain forms has harmful effects on forest, soils, plants, animals, and fish. For example, the U.S. Forest Service expressed concern over the "substantive reduction in timber volume caused by chronic low levels of $SO_2$ or acid rains."[30] A study by the Swedish Government showed that acid rain could result in the loss of as much as 15 percent of the Swedish softwood forest by the year 2000. Scandinavia has experienced a substantial decline in fishery resources due to acid rain.[31] The Adirondacks Park Agency reported that increased acidity in two-thirds of the lakes in the five wilderness areas of New York State has threatened the indigenous fish population of brook trout.[32]

*Ecosystems may be damaged.*

The delicate balances in natural ecosystems could be altered by chronic and long-term $SO_2$ exposure. Changes in plant life, through the elimination of sensitive species, would, in turn, affect animal life through changes in habitat or food availability.[33] Considerable research is needed, however, to achieve a fuller understanding of the adverse effects of air pollution on ecosystems.

*Climate and weather*

*Air pollution may alter climate and weather.*

Pollutants such as carbon dioxide, particulates, and thermal discharge may alter the delicate atmospheric balance which determines weather and climate. The effects may be local, regional, or even global in scale. The impact of increased amounts of carbon dioxide on the earth's temperature has recently become the subject of considerable interest. Although the consequences may be severe, information is inadequate to evaluate the effects.

*Materials*

The adverse effects of air pollution on materials includes the corrosion of metals, deterioration of rubber , fading of paint, and soiling of surfaces. Sulfur oxides, mostly in the form of sulfuric acid, can cause "the corrosion of metals, damage to electrical contacts, deterioration of paper, textiles, leather, finishes and coatings, and erosion of building stone through conversion of calcium carbonate to the soluble sulfate."[34] Although the major effect of particulates is the soiling of exposed surfaces, they may also act as catalysts increasing the corrosive reactions between metals and acidic gases.

*Visibility*

*Will the NAAQS protect visibility?*

The secondary NAAQS were not specifically designed to protect visibility. As Senator Muskie has pointed out,

> ...if the secondary standards were the only restraint on new sources in clean air regions, visibility which is now 100 miles or more in some areas could deteriorate to 12 miles. If humidity is high, visibility would be reduced even further.[35]

The protection and enhancement of visibility in Federal Class I areas was declared to be a national goal in the 1977 Clean Air Act Amendments. In vast areas of the West and Southwest, excellent visibility is considered a valuable asset; it is believed that the public places high value on such visibility. Degradation of such visibility could harm the tourist economies of states such as Colorado or Arizona. However, few data or models are available for determining the expected physical changes in visibility from increased levels of air pollutants, or for evaluating the importance that changes in visibility might have among residents of and visitors to the West.

*EPA will issue regulations to protect visibility.*

EPA has been given responsibility for developing "methods for identifying, characterizing, determining, quantifying, and measuring visibility impairment,"[36] and has initiated efforts to measure visibility quantitatively. In one research effort, visibility was "defined with respect to a measure of contrast which changes as a function of light-source position and the position of object and observer with respect to each other."[37] A prototype monitoring station is under preparation near a national park in Utah to develop instrumentation for measuring visibility and to estimate correlation between effects and the source of pollutants.[38] Some of the provisions of the 1977 Amendments[39] covering visibility are specific:

- Best available retrofit technology will be required on major sources less than 15 years old if they contribute to visibility impairment.
- Power plants of capacity greater than 750 MW will have an emission limitation established on a visibility basis by EPA.
- Regulations will be promulgated by EPA within two years to assure reasonable progress towards the national goal.

How EPA defines and measures visibility, and what regulations are established to prevent the impairment of visibility will have far-reaching consequences for energy development, particularly in the western United States.

CONTROL TECHNOLOGY

*What is BACT?*

The PSD provisions of the CAAA of 1977 require a review process, prior to granting a permit to construct, to ensure that the proposed new facility uses the best available control technology (BACT). The term BACT is defined as:

> an emission limitation based on the maximum degree of reduction of each pollutant subject to regulation under this Act emitted from or which results from any major emitting facility, which the permitting authority, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such a facility through application of production processes and available methods, systems, and techniques, including fuel cleaning or treatment or innovative fuel combustion techniques for control of each such pollutant. [40]

EPA intends to require BACT on all criteria pollutants in a preconstruction review for all sources with the potential to emit more than 100 tons of any pollutant per year. A proposed new source might be required to use BACT for sulfur dioxide, total

*BACT will be required for all CAAA pollutants.*

suspended particulates, nitrogen oxides, hydrocarbons, photochemical oxidants and carbon monoxide, as well as for those pollutants regulated under NESHAPS and under standards for mobile sources, instead of being limited to the two pollutants for which increments have been established, sulfur dioxide and particulates.

PSD will apply to all new major sources of emissions in the 28 specified categories; in the past, power plants burning coal and oil to produce electricity have been the most significant source of $SO_2$ and TSP. EPA has commented, "as a class, the 688 large coal and oil-fired plants in the U.S. emit nearly 60% of the total national emissions of $SO_2$ and are heavy contributors to ambient particulate loadings."[41] The experience of the utility industry in achieving compliance with emission limitations under NSPS can provide useful indications of the capabilities of control technology and of areas in need of research.

*Control of Sulfur Dioxide*

*What methods are available for $SO_2$ control?*

Present NSPS for coal-fired boilers cover emissions of suspended particulates, sulfur dioxide and nitrogen oxides. Compliance with particulate and nitrogen oxide standards generally has been achieved, but $SO_2$ control has been more difficult to achieve, "with about 43% of the coal burned for the generation of electricity in 1975 not meeting emission regulations".[42] The present technologies for controlling $SO_2$ emissions from conventional power plants are flue-gas desulfurization systems (FGD), physical washing of coal, and the burning of low-sulfur coal; chemical washing and fluidized-bed combustion are in the experimental stage. The CAAA of 1977 specifically precluded the use of untreated fuel, such as low-sulfur coal, without additional control as a method of limiting emissions.

*Coal cleaning has possibilities.*

(i) Coal cleaning. Coal preparation is an established commercial process which upgrades the quality of coal and assists in the control of environmental problems. With some coals, the sulfur content can be reduced enough to meet sulfur emission standards of the present NSPS without the use of an FGD system. The potential sulfur reduction depends on the characteristics of the particular coal and the process technology.

Sulfur occurs in coal in three forms: pyritic sulfur, organic sulfur, and sulfate sulfur (rarely). Pyritic sulfur accounts for, on the average, about 60 percent of total sulfur in coal. Tests indicate that approximately one-half of this can be removed by conventional washing techniques. Therefore, about 30 percent of total sulfur can, on the average, be removed by such treatment. The U.S. Bureau of Mines, in a recent report on coal characteristics, has estimated that about 24 percent of a total of 455 coals tested could be cleaned sufficiently to meet present NSPS with no additional control technology.[43] Organic sulfur, which averages about 40 percent of total sulfur in coal, is not reduced by commercial coal preparation. Techniques for chemical cleaning of coal to remove additional inorganic sulfur and some portion of organically bound sulfur are currently in the research and development stage.

*Scrubbers are the major option presently available.*

(ii) Flue-gas desulfurization (FGD). FGD is a general term used to denote processes for the chemical or physical removal of sulfur dioxide from flue gas, usually by means of a stack gas scrubbing action. FGD systems are the major option currently available to utilities for achieving continuous control of $SO_2$ air emissions.

More than 50 FGD processes have been proposed and developed to varying degrees. The systems can be characterized generally as "wet," if the $SO_2$ is absorbed in a scrubbing action, or as "dry," if the $SO_2$ is absorbed on or reacts with a solid; and as "throwaway," if the sulfur product is not recovered or as "regenerable," if the sulfur or sulfuric acid is removed and marketed. Approximately 80% of the currently installed FGD systems in the United States, and 90% of the installations planned, are based on wet, throwaway processes, usually using lime or limestone.[44] According to EPA estimates, as of August, 1977, there were 29 FGD systems in operation on 8,900 MW of power production in the United States, with an additional 28 under construction (11,800 MW) and 68 planned (32,600 MW). FGD systems "have covered only three percent of utility coal-fired generating capacity...with an increase to 15% in 1980..."[45] predicted by EPA.

*But scrubbers have maintenance problems...*

The reliability of FGD systems has been the subject of considerable controversy between EPA and the electric utility industry. The utilities assert that the maintenance problems of FGD systems (such as the deposition of solids on equipment, and the plugging and corrosion of pipes) have led to "many cases of units operating at 50% availability for several months at a time."[46] EPA has stated that "the problems are now sufficiently understood that systems can be designed and operated with good reliability"[47] and that FGD systems, properly maintained, can operate consistently at 80%, or higher, reliability and 80%, or higher, efficiency of sulfur removal.[48]

*...and produce large amounts of sludge.*

The solid waste, or sludge, resulting from a lime/limestone process presents a significant disposal problem. The amount of sludge depends upon the sulfur and ash content of the coal burned in a particular unit. It has been estimated that "a new 1,000 MW plant equipped with a limestone scrubber and burning coal with 3% sulfur and 12% ash will produce in the first 10 years of operation a quantity of waste that covers 1 square mile to a depth of 10 feet."[49] The sludge is typically a semi-liquid suspension which, if simply ponded, not only removes land from other uses but may be a source of groundwater pollution through leaching. Several commercial methods have been developed to solidify the

*Regenerable scrubbers are used in Japan and are being developed in the U.S.*

sludge and make the product stable enough for use in construction or road beds. Several regenerable FGD processes are operating in Japan, and there are approximately a dozen major regenerable systems for power plants at various stages of development in the United States. A number of these processes have been installed on commercial facilities, but their use on coal-fired boilers has been limited. Regenerable processes are not expected to be used extensively in the United States before 1985.

*Fluidized-bed combustion can remove up to 90% of sulfur in coal.*

(iii) Fluidized-bed combustion.[50] Another approach to reducing $SO_2$ emissions is to absorb the gas during the combustion process. DoE and other Federal agencies are presently supporting research on the fluidized-bed combustion of coal, which could offer significant advantages in the areas of capital and operating costs, and environmental protection, in comparison to conventional coal combustors with FGD systems. The sulfur dioxide undergoes a chemical reaction with crushed limestone in the bed, to form a stable solid. It has been estimated that at least 90 percent of the sulfur in coal can be retained in the bed. Although the process results in substantial quantities of solid waste, the discharge is dry, with possible disposal options such as landfill, as a gypsum substitute in the manufacture of wallboard or as filler material in cement and cinder blocks.

Emission levels of nitrogen oxides from a fluidized-bed combustor are much lower than in conventional combustors, as a result of lower combustion temperatures. The fluidized-bed technology may result in higher levels of solid particulates than conventional combustion. The extent of the problem and the techniques for control of such particulate loading are still undergoing research. There is some experimental evidence suggesting that fluidized-bed combustion will produce lower levels of trace element emissions and less concentration of trace elements in fly ash particles.

Although there is virtually no data on emissions of hydrocarbons, concern has been expressed that the relatively low combustion temperatures in a fluidized bed may actually increase the emission of some hydrocarbon compounds.

Fluidized-bed combustion is still in the research and development stage with commercial operation in major power plants not anticipated until the late 1980's, depending on the degree of success of pilot and demonstration plants.

*Control of Total Suspended Particulates*

*What methods are available for particulate removal?*

Control technology for large particulates has been well established, and compliance with existing NSPS emission levels has generally been achieved. Several techniques are commercially available, in particular, electrostatic precipitators (ESP) and fabric filters (or baghouses). At present, electrostatic precipitation is the predominant means of particulate removal for coal-fired power plants. Removal efficiencies of over 90% can be readily achieved. However, ESP technology may not be adequate to meet a collection efficiency of 99%, such as EPA is considering in its revision of NSPS, or for possible future regulations on the emissions of fine particles (less than 1 micron in diameter). 51

Fabric filters have been used for many years to remove dust from industrial process gases and have been installed on small utility boilers. Baghouses can function effectively with particle sizes and electrical properties of fly ash that present problems to an ESP unit. Filters have higher maintenance costs and may require more energy to operate than electrostatic precipitators. Utility experience with baghouses is somewhat limited and restricted to small units; however, 99.8% removal efficiencies have been achieved on small-sized boilers (less than 500 MW).

Fly ash may also be removed by a wet scrubber technology; however, operating and maintenance costs are estimated to be twice the level of a baghouse or precipitator. Wet scrubbers are seldom used for particulate removal only but are generally installed for both particulate and sulfur oxide control.

*Control of Nitrogen Oxides*

*What methods are available for $NO_x$ control?*

The 1977 extension of the schedule for automobile emission reductions of nitrogen oxides may make control of the pollutant from stationary sources more important. Coal-fired utility boilers contribute 32% of the 20 million tons of $NO_x$ emitted each year in the United States. Combustion modification, the primary control technique, has achieved reductions of $NO_x$ emissions from oil-fired boilers by up to 50%, although significant modification is required. EPA has a major effort underway to develop combustion modification technologies for utility and large industrial boilers. Field tests of combustion modification on coal-fired utility boilers have resulted in $NO_x$ reduction of from 30% to 50%.[52]

For new installations, modified burner designs have the potential for achieving major $NO_x$ reductions. If combustion modification techniques are not adequate to meet new $NO_x$ emission limitation levels, flue gas $NO_x$ treatment may be required. A number of these $NO_x$ flue gas processes are under investigation; in general, the costs are comparable to an FGD system and are considerably higher than combustion modification techniques.[53]

*Areas in Need of Research*

*Control technology will be needed for other pollutants.*

Research is being conducted on control technology for hydrocarbons, as well as for other pollutants such as trace metals, polycyclic organic matter, and fluorides. Radioactive emissions, classified under the new CAAA as an air pollutant, may be regulated by EPA if it is determined that such emissions have adverse health effects. Fossil fuels contain radioactive impurities, and if regulations are promulgated, control technology would need to be developed.

*What pollutants are emitted by newer combustion methods?*

Additional research is needed to identify more fully the types and levels of pollutants and the effectiveness of control technology for developing energy technologies. Coal gasification pollutants include particulate matter, sulfur dioxide, nitrogen oxide, and hydrocarbons. Liquefaction pollutants have not yet been clearly identified, but hydrocarbon emissions could be high; for magnetohydrodynamic systems, control of suspended particulates and nitrogen oxide may represent serious problems.

*Emission control needs research.*

Research could be expanded into improved control technologies for conventional combustion, such as regenerable scrubbers, coal preparation on a more intensive level (both physical and chemical cleaning, for example) or combinations of coal preparation with FGD systems. Although much of control technology research is aimed at major sources, clusters of small, uncontrolled sources could emit significant aggregate pollution concentrations, use up PSD increments, and constrain further growth. Research efforts might be usefully directed towards developing affordable, energy-efficient, and environmentally sound control technologies for smaller sources of emissions.

## IMPLEMENTATION

*What PSD regulations has EPA proposed?*

EPA published proposed rulemaking for PSD regulations on November 3, 1977; final regulations are expected to be promulgated March 1, 1978. The proposed rules reflect EPA's judgment of Congressional intent and of administrative feasibility, and may be changed before final promulgation. Areas where EPA has exercised discretion in determining regulations may be open to challenge in the courts.

### *Allocation of Increments*

The Clean Air Act Amendments state that at the time of the first PSD permit application in any area, the ambient pollutant level will

*What emissions will be counted against the increment?*

be measured and designated the "baseline concentration" by EPA. Included in this baseline will be the projected emissions from facilities on which construction commenced before January 6, 1975, but which are not yet in operation. The projected emissions from all new major sources will then be counted against the available increment. However, should the ambient concentration at some time in the future be close to the permissible NAAQS, then the amount of air quality deterioration permitted would be either the difference between the baseline concentration and the NAAQS or the allowable increment, whichever is smaller. In addition to emissions from major emitting facilities as defined, emissions from secondary sources (industrial, commercial, residential, automobile, etc.) are to be counted against the available increment. These emissions are to be incorporated by periodic updating of EPA's emission inventory. These new minor sources may have the potential to use up the available increments at a fairly rapid rate, if current patterns of urban growth continue. Senator Muskie has stated:

> The States are expected to avoid using up this safety margin with pollution from non-major emitters ... If efforts are not made to control these sources ... the patterns that create such pollution -- such as sprawl requiring excessive transportation -- will already be established ... It would be of little value to have carefully reserved the option of States to make balancing judgments in relation to the degree of emission reduction beyond that required by the increments if, in the absence of careful consideration of non-major emitters, the growth capacity were frittered away. [54]

*EPA and the CAAA differ on baseline definition.*

EPA's immediately-effective regulations implement the definition of baseline concentration given in the Clean Air Act Amendments. However, EPA's proposed regulations would redefine baseline concentration as that "level reflecting air quality as of January 6,1975." The difference between the two regulations is that increases in pollution from minor sources between January 6, 1975, and the time of the first permit application will be counted against the increment in the proposed regulations, rather than be counted into the baseline. This is in conflict with the Congressional definition. The effect will be to reduce the increment available for new development. This effect could be important in rapidly-growing areas where commercial, residential, and transportation emissions are increasing, and there is little potential for reduction of emissions from existing sources.

EPA also intends to count against the increment any immediate and well-defined secondary emissions which will accompany the new source. This would again reduce the available increment and could be a significant factor in the siting of facilities that lead to large associated growth or "boom towns."

*How will increments be allocated?*

It is assumed that increments will be allocated on a first-come, first-served basis. The courts have upheld this approach in other contexts. For example, in a 1976 decision later upheld by the State Supreme Court, an appellate court in New Mexico disallowed state regulations that were intended to provide a clean air reserve for future use. The state had required more stringent emission controls on existing coal-fired plants than would have been necessary to meet the NAAQS. However, if latitude is allowed in the allocation of increments it is possible that a state might be able to reserve a portion of the increments for subsequent use by energy facilities.

*Atmospheric Modeling and Monitoring*

*Atmospheric modeling is used to estimate emissions.*

Air dispersion models are used to estimate projected emissions from a proposed new major source of emissions. The models are used to determine the maximum size of a plant that could be built at any given site without violating the PSD increments, and the distance that a plant would be required to locate from a Class I area in order not to violate the latter's increments.

*How accurate are current models?*

The EPA has used Gaussian plume models to determine the dispersion of airborne pollutants from a specific source at a specific site. It is generally agreed that these models, while representing the current state of the art, are far from accurate in predicting concentrations over very large distances. It has been suggested that the greatest error may be in the estimation of distances required between major pollution sources and Class I areas.

EPA is tending to favor a modeling approach to the implementation of PSD legislation, rather than a monitoring approach. The proposed regulations do not include monitoring requirements to determine increment usage. Atmospheric modeling of individual sources and secondary growth will be used to keep track of unused increments. EPA's reliance on modeling raises doubts as to the capabilities of existing models. Can they, for example, model the transport of all criteria pollutants with sufficient accuracy? In many cases the available increments are so small that great care must be taken in the modeling procedure for secondary emissions.

The amendments require EPA to conduct a modeling conference within six months and at least every three years thereafter, giving special attention to PSD requirements. Clearly, the way in which sources and emissions are modeled is crucial to the implementation of PSD.

*Monitoring will also be required.*

Although EPA plans to rely heavily on modeling, an increase in the amount and type of air quality monitoring can be expected as a result of PSD. The law requires operators proposing to construct a new major emitting facility to monitor air quality for up to one year at the proposed site before a permit is applied for. Monitoring for less than one year will be permitted if the time period of monitoring covers the probable period of maximum pollution levels. Monitoring of pollutants other than TSP and $SO_2$ may be necessary in the near future. However, the reliability and accuracy of monitoring devices have been questioned. The 1977 amendments require EPA to establish standardized criteria within one year that will be used in future monitoring.

*PSD and Non-Attainment Areas*

*A proposed new source may affect both a PSD area and a non-attainment area.*

EPA intends to require a PSD review of proposed new sources in both attainment and non-attainment areas of the country. A source seeking to locate in a non-attainment area might have an effect on clean-air areas through the long-range transport of pollutants. Similarly, a source wishing to site in a PSD area will be reviewed for possible impacts on adjacent non-attainment areas. If the new source will increase pollutant concentrations in a non-attainment area, an emission-offset agreement would be needed, although it is not clear whether all the requirements of emission-offset legislation (including the use of lowest achievable emission rate and clean-up of other sources owned by the same owner) would have to be met.

If a non-attainment area is large, it might include some small clean-air areas. EPA has noted that a strategy to protect such clean-air areas will be needed -- one possible approach might be allowing the states to handle the geographic applicability of PSD increments on a case-by-case basis. The total siting constraints of simultaneously complying with both PSD and non-attainment regulations may be significant.

*"Significant" long-range impact may be estimated.*

EPA is considering incorporating long-range impacts on PSD areas into the scheme. Fundamental problems are likely in determining what "significant" long-range impact could be permitted on PSD areas. EPA has already suggested that significant air quality increments of $SO_2$ for non-attainment areas would be any concentration increase greater than one microgram per cubic meter for an

*Can models predict a long-range impact?*

annual average, 5 $\mu g/m^3$ for 24-hour averages, and 25 $\mu g/m^3$ for 3-hour averages.[55] EPA has not yet determined a significant impact level for PSD areas. The capabilities of models or monitors to achieve prediction or measurement of such small increases have been questioned, although EPA asserts that "computer modeling techniques can predict small impacts on increments for sources hundreds of miles from the impacted area."[56] EPA has not indicated whether the "significance" test will be applied only to areas where the increments have been used up, or whether the emissions will be counted against the increments in all areas. It is also not clear whether EPA would establish a limit on accumulation of allowable long-range impacts in a given area. The siting constraints likely to result from this cannot be estimated until a specific scheme is proposed by EPA.

*New Source Review*

*There is some confusion over the sources covered by PSD.*

Sources subject to preconstruction review are the 28 categories listed in the CAAA. However, there is some ambiguity in the law over the terms "source" and "facility." Where there exist a number of different facilities comprising a given stationary source, a possible interpretation of the law would allow point sources having the potential to emit no more than 250 tons per year (rather than 100 tons per year) to be exempt from PSD review.

Clarification is needed over the size of fossil-fueled plants which would be subject to the regulations. If such a plant has less than 250 million Btu per hour heat input, but the potential to emit more than 250 tons of a pollutant per year, is it a "major source" subject to review?

EPA is also considering a set of short-term emission criteria for the determination of source applicability. For example, not only would sources emitting more than 100 tons per year come under review, but also sources emitting more than 1,000 lbs per day or 100 lbs per hour.

*Elements in phased construction may be regulated individually.*

In its proposed regulations, EPA noted that each major source in a phased construction project would be reviewed separately. For example, if a utility planned three boilers at the same site, each of which would be large enough to qualify as a major source, then even if the first boiler had commenced construction before the new regulations became effective, the remaining boilers would have to comply with PSD requirements in effect when construction on them begins. This may have a major impact on construction plans of the utility industry.

EPA's proposed rules will expand the coverage of major modifications under PSD review. Previously, modifications that did not result in a net increase in emissions were exempt from the new source review procedures. EPA intends to require a BACT review for any major modification, although if emissions are not increased, a review for increment violations would not be required. Sources which convert voluntarily from gas or oil to coal are considered modifications and are subject to PSD review, if the source was not designed prior to January 6, 1975, to accommodate the alternative fuel.

*Is the new source review procedure adequate to implement PSD?*

The preconstruction review process is the enforcement procedure established for implementing PSD; however, in a supplement published December 8, 1977,[57] EPA asked whether procedures beyond the preconstruction review will be needed to implement PSD. The question is based on two sections of the CAAA of 1977: Section 161, requiring that SIPs contain emission limitations and such other measures as may be necessary to implement PSD; and Section 163, requiring that SIPs contain measures to ensure that increments not be exceeded. If the preconstruction review process is the only method of enforcement, increments could be violated by emissions from sources not subject to the review procedure or by emissions from sources that received a PSD permit based on modeling, but were revealed by subsequent monitoring to be exceeding projected emissions. EPA's previous interpretation of PSD did not require a "clean-up" if increment levels were inadvertently violated, but prevented additional new sources from siting unless the violations were corrected. If the increments are viewed as absolute statutory requirements to be protected by whatever combination of regulatory measures is necessary, then the implementation of PSD could have far-reaching effects on the siting of new facilities.

*Best Available Control Technology (BACT)*

*BACT is to be set on a case-by-case basis.*

New sources will be required to employ BACT, as determined by the permitting authority on a case-by-case basis for all criteria pollutants, in contrast to EPA regulations which automatically applied New Source Performance Standards. EPA has determined that if an emission limitation is technologically or economically infeasible, the Agency would follow the procedures established under NSPS, and require a design or equipment standard instead.

EPA is proposing that BACT be required for all pollutants regulated under NAAQS, NSPS, NESHAPS, or regulations for mobile sources if the source is subject to review and the potential emissions are greater than 100 tons per year. The definition of "potential to emit" could be significant. EPA has determined that "potential" emissions are those expected to occur without control technology, unless the control equipment is integral to the operation of the source. This would presumably aid technologies that have inherent or "built-in" pollution controls, but would make many more sources subject to review.

EPA is considering establishing a centralized system to inform states of BACT determinations by the states and EPA, but is undecided on the appropriate role of the Agency in establishing guidelines for BACT, or in achieving national consistency in BACT.

*Is national consistency in BACT possible or even appropriate?*

The CAAA clearly reserve the determination of BACT to the permitting authority -- either the states or EPA. States would be able to limit the amount of growth within the increment levels by requiring more stringent emission limitations.

*Fuel Conversion*

The CAAA specifically allow a state to exempt emissions from sources converting from gas and oil to coal for up to five years, if the conversion were ordered under ESECA or were the result of a natural gas curtailment plan. EPA argues that it does not have the authority to allow such exemptions in its regulations, but that the state SIPs could include an exemption. In the interim before SIPs are submitted and approved, conversions could use up significant portions of the increment in an area. The five-year exemption would enable a converting facility to install control equipment, reducing the amount of the increment eventually used.

## V. ANTICIPATED EFFECTS OF PSD LEGISLATION

*What are some of the effects of PSD?*

The implementation of prevention of significant deterioration regulations will have an effect on economic growth, both on a national and regional level, as a result of the possible constraints on the siting of new industrial and utility facilities and of the costs of compliance. The comparative attractiveness to utilities and industries of various energy technologies will be affected, with PSD encouraging the development of improved emission control technology and of those energy technologies which are inherently less polluting. The increased costs of electrical generation may encourage the development and use of conservation and energy efficiency-improving measures. The magnitude of these effects will be a function of the path of implementation followed by EPA and the states, the response of the regulated industries, and, probably, the decisions of the courts in subsequent litigation.

*What are some of the benefits of PSD?*

These effects must be viewed in the context of the purpose of PSD -- to protect health and welfare from adverse effects of air pollution not anticipated by the NAAQS; to preserve, protect and enhance air quality in unique public lands; to ensure that economic growth will not conflict with air quality goals; and to assure that increases in air pollution are allowed only after careful evaluation and public participation. As the National Academy of Sciences stated:

> Preservation of the aesthetics of the physical environment is a primary intent ... [of PSD]... A National commitment to preserve or enhance air quality can also be defended in terms of the reasonableness of avoiding the risks of serious impacts of air pollution on human health and ecosystems.[58]

The benefits of PSD will derive from the maintenance of an aesthetic quality of the environment and reduced human and ecosystem exposure to airborne pollutants.

ECONOMIC EFFECTS

Compliance with PSD regulations may entail a significant cost for new industrial or energy facilities. Electric utilities, presently the major industrial users of coal, will initially be the most seriously affected by the increased costs of compliance; their costs have been studied exhaustively and will be examined below. Under the National Energy Plan's goal of increased utilization of coal, however, costs associated with PSD will ultimately affect a broad array of industrial facilities.

*Costs of PSD include "non-optimum" siting.*

If, during the preconstruction review process, atmospheric modeling predicts that a proposed new source will produce emissions in a local clean-air area or an adjacent Class I area in excess of the non-deterioration increments, a permit to construct would be denied unless emissions were limited further, or the source was reduced in size or relocated to an alternative site. The costs of such "non-optimum" siting for a utility, for example, would include (presumably greater) expenses for cooling water supply, for extended rail or barge transportation of fuels and wastes, and for longer transmission lines and more substations. The cost of a reduction in size would be the economies of scale lost and possibly greater costs for a supplemental source. These costs may be significant but can be estimated only on a site-specific basis.

*Costs of PSD for Electric Utility Industry and Consumers*

*What are some estimates of the capital costs of PSD compliance?*

The capital costs of compliance with the PSD amendments proposed by the House and Senate in 1976 have been estimated as between $10.1 and $16.5 billion over the period 1975-1990 (based on studies conducted by the EPA, the Federal Energy Administration and National Economic Research Associates).[59] These estimates assume that BACT will require scrubbers on all post-1980 coal-fired power plants and that all emission limitations beyond the level required to comply with

*The 1976 version of PSD would cost consumers an annual extra $14-$35 for electricity in 1990.*

the current NSPS are the result of BACT. The capital costs would represent a 2 to 4% increase over the projected capital investment of utilities for the same period. Consumers could expect to pay an additional $14 to $35 (in 1975 dollars) on their yearly bill in 1990 per household for electricity (including both direct costs on utility bills and estimates of electrical costs in goods and services purchased), or a percentage increase of 1.0 to 3.0%.

*Projected electricity demand is an important assumption.*

FEA's study, representing the high end of the range of estimated costs, assumed that most new coal-fired plants would be operated at intermediate load, requiring more new plants to meet a projected 5.5% annual increase in demand, and that BACT would require low sulfur coal and scrubbers in the West and washed high sulfur coal and scrubbers in the rest of the country. EPA based its estimates on a projected growth in the demand for electricity of 5.3% per year over the 15 year period. If conservation measures make an appreciable difference in the demand for electricity, or if increased costs of electricity encourage a reduction in demand, the rate of growth of electric generating capacity will be reduced. For example, in an EPA study of the proposed PSD amendments of the 94th Congress, an energy conservation scenario (peak load growth over 1975-1990 of 4% per annum in comparison to 5.3%) reduced the impact of the House proposal (considered to be the more restrictive) on capital costs for the electric utility industry from $11 billion to $7 billion.[60] The precise dollar estimates are not relevant to the present amendments, but the potential reduction in costs resulting from conservation is important. Realization of the energy conservation goals of the National Energy Plan may have a significant impact on the costs associated with PSD for the electric utility industry.

In a March 1977 study, NERA[61] estimated that compliance with the 1977 Congressional PSD legislation would increase capital requirements by $22 billion over the period 1976-1990, *The 1977 Amendments may make electricity 4% more expensive in 1990.*

approximately a 5% increase over the total of both estimated capital investment for the industry and the costs of complying with the present NSPS. Annual operating costs in 1990 would increase by $4.6 billion, a 4% increase over costs without PSD. The costs of electricity per household were estimated as an additional $48 in 1990, or a 4% increase over estimated consumer costs in 1990 in the absence of PSD regulations. NERA's assumption that scrubbers would be required on all new plants had the most significant cost impact, and "removing this provision, and assuming that plants are allowed to meet current NSPS by whatever means is most appropriate"[62] would reduce the operating cost in 1990 from $4.6 to $2.74 billion. If the emission limitation required by revised NSPS is equivalent to a "scrubbers everywhere" assumption, 40% of the costs attributed to PSD compliance may be more appropriately attributed to NSPS, as revised.

*But a little less than half of that increase may be the result of revised NSPS.*

NERA's costs are based on an assumption of an average plant size of 3,000 MW for added capacity after 1980, in order to benefit from economies of scale and to allow room for other industrial sources to co-locate with a new power plant. However, 3,000 MW is considerably larger than the size planned for new facilities; this assumption may overestimate the costs of relocating since smaller facilities would be less constrained by the ceilings on increments. The cost estimates are also sensitive to assumptions on the diffusion modeling used to estimate required emission limitations. NERA's assumption of modeling over five years with an emission level that would result in not more than one violation of the standard in the worst of those years may overestimate costs in comparison to the use of a single year of meteorogical data.

*Costs of Emission Control*

Most of the available data on the cost of control technology are based on experience with coal-fired power plants and current

(December, 1977) NSPS emission limitation levels. For a proposed energy facility, the cost attributable to PSD is only the incremental cost for emission limitation in excess of the level required to comply with the appropriate NSPS. EPA is presently reviewing NSPS for coal-fired utility boilers; revisions are expected to be promulgated in March, 1978. The BACT review under PSD may require more stringent emission control than NSPS; this conclusion is presently uncertain, however, and depends on the NSPS levels set by EPA. For example, in the first area redesignated as Class I -- the Northern Cheyenne Indian reservation in Southwest Montana -- EPA has determined that to meet BACT two proposed additions to the Colstrip power plant, adjacent to the reservation, will be required under PSD to remove 85-90% of the sulfur dioxide in the flue gases.[63] But, if EPA sets the NSPS at 90% sulfur removal, PSD would not have imposed additional control requirements in this case.

*PSD costs are only the incremental amount over the costs of meeting NSPS.*

Until new NSPS are promulgated, estimates of the incremental emission costs of limitation to achieve PSD compliance cannot be made; however, the costs of existing control technology for sulfur dioxide, total suspended particulates,and nitrogen oxides can provide an indication of the potential economic impact of more stringent emission limitations. Although EPA intends to require a BACT review for these three pollutants, as well as for hydrocarbons, carbon monoxide, and oxidants, information on emission levels, control technology, and costs for the latter three is inadequate for further discussion here.

*What are some estimates of emission control costs?*

(i) Sulfur dioxide control. The costs of Flue Gas Desulfurization (FGD) systems (scrubbers) are sensitive to a number of factors, including the size of the system, the sulfur content of the fuel, the degree of redundancy employed, the energy required to operate the system (4% of total plant capacity estimated for lime/limestone scrubbers), and the type of installation (new or retrofit). In general, the costs of retrofit installations are higher than those of new units with controls

*Scrubber costs depend on a number of assumptions.*

designed as part of the system. The degree of redundancy selected will be influenced by administrative interpretation of the standards for emission control; if an entire boiler unit is required to shut down when a scrubber malfunctions, a power plant would need excess scrubber capacity or additional plant capacity to maintain output. The costs of sludge disposal may or may not be considered as a capital expense; at some sites where the existing facilities are adequate to handle the solid waste, the cost may be negligible, while at other sites the sludge disposal capital costs (for example, purchasing land for dumping) may be one-fourth to one-third of the total cost of $SO_2$ control.[64]

*Estimates of capital costs of scrubbers range from $33 to $135 per kilowatt.*

According to one recent estimate, capital costs for a limestone system on a new 500 MW plant burning 3% sulfur coal might range from $70 to $100/kW and annual operating costs might range from 4 to 6 mills/kWh.[65] EPA estimates (prepared by Pedco & TVA) for a lime/limestone system achieving 90% sulfur removal are capital costs of $50 to $88/kW and operating costs of 2.7 to 5.1 mills/kWh, assuming that on-site sludge disposal is available.[66]

Another survey[67] of a number of existing FGD installations showed capital costs from $33 to $135/kW, and operating expenses from 1.3 to 5.5 mills/kWh. For a sample of 19 coal-fired power plants, the weighted average capital cost was $90/kW and 3.1 mills/kWh for operating costs. The weighted average of capital costs was $86/kW for new units compared to $94/kW for retrofitted units. On retrofitted plants, the annualized costs are higher, since the lifetime of the plant is assumed to be shorter. The increased capital costs of an FGD system over the use of untreated low sulfur coal for investor-owned electric utilities is small (1.7%) compared to the total capital requirement of those utilities, but the differential cost of the scrubber is significant (14%) when compared to the total cost of an individual plant.[68]

The costs of regenerable scrubber systems are less certain, but estimated costs, including sale of the by-product, range from 20% less to 20% more than lime/limestone systems, depending on the energy required for operation.

*Combining coal cleaning and scrubbing might reduce costs.*

The costs of coal cleaning are less well known, although the costs of a combination of coal washing and FGD are under study. The characteristics of a particular coal are significant factors in the estimates. For example, a new power plant, using Pennsylvania coal with 3.5% sulfur and 11.4% ash content, can achieve a 2% reduction in the costs of meeting current NSPS by using a combination of cleaning and FGD in comparison to FGD alone, according to EPA estimates. The combination reduces costs by 50% for another Pennsylvania coal (2.4% sulfur and 11.4% ash).[69]

*Control of particulates costs less than 1 mill per kilowatt hour.*

(ii) Total suspended particulates control. Operating costs for particulate control depend on the sulfur content of the coal and the operating capacity of the plant. Operating costs for an electrostatic precipitator (ESP) achieving 99.7% removal of particulates on a 500 MW unit have been estimated from 0.8 mills/kWh for 1.5% sulfur coal to 0.55 mills/kWh for 3% sulfur coal. (The higher operating cost for lower sulfur coal is a result of the difficulties encountered in collecting high resistivity ash.) A recent study comparing operating costs of electrostatic precipitators and baghouses concluded that "for coals having sulfur contents below about 1.1%, baghouse units will have lower operating costs than ESP for a collective efficiency of 99.7% ... for a 99.9% removal the breakeven occurs at about 1.75%."[70]

(iii) Nitrogen oxides control. Combustion modification techniques are the lowest cost method of reducing $NO_x$ emissions. Additional capital costs for a 500 MW utility boiler have been estimated as $0.55/kW (in 1974 dollars) for an existing plant and $0.14/kW for a new unit. Operating costs average less than 0.01 mills/kWh. Additional emission reduction by flue gas treatment, if sufficient $NO_x$ suppression cannot be achieved through burner modification, will result in costs comparable to FGD systems.[71]

FACILITY SITING/SIZE

Compliance with PSD increments may result in constraints on the siting or size of new major sources of emissions; the degree of constraint depends on the emission reduction achievable by use of the best available control technology, the size of the available increment, the proximity of a Class I area, and the terrain features of the proposed site.

*Facility Size within a Class II Area*

*What size power plant can be built within Class II increments?*

A number of studies have been conducted to estimate the impacts of PSD on the siting of new facilities, each making assumptions about the level of emission control. In all cases, it was assumed that the proposed facility would have the total Class II increment available.

(i) Electric generating facilities. A report by Environmental Research & Technology, Inc. concluded:

> "For the increments limits specified in S. 253 ... [adopted in CAAA, 1977] ... the maximum capacity power plant which could be built, even at an ideal site (i.e., a site with flat terrain, favorable meteorological conditions, and no Class I area within 100 kilometers, or 60 miles) would be less than 2,700 MW if the $SO_2$ emission limits for the plant were maintained at the present EPA New Source Performance Standards."[72]

*The size depends on the emission levels and the terrain of the site.*

ERT examined the constraints of hilly terrain, which traps the emissions, on the maximum size of a new generation facility, concluding that "no new 1,000 MW unit can be operated at the EPA NSPS limits, if terrain elevations greater than stack height occur at a location within 20 kilometers (12 miles) of a plant site."[73] The short-term (3-hr and 24-hr) $SO_2$ emission increments are usually the limiting factor in the analyses. The requirement to employ BACT, however, may significantly increase these maximum sizes.

In a study of the impact of the 1976 Senate proposed amendments, EPA concluded that "the construction of major, economically-sized industrial facilities would not be prevented,"[74] estimating that a coal-fired power plant between 1,100 and 4,000 MW, in compliance with NSPS emission limitations of 1.2 lbs $SO_2$/ million Btu, could be built in flat or moderate terrain without violating Class II increments. In a study of the 1976 House proposed amendments, EPA concluded that in flat or moderate terrain a 1,000 - 1,700 MW power plant meeting NSPS could be built without violating Class II increments; if emissions were controlled to a range of 0.12 to 0.46 lb $SO_2$/million Btu, the maximum size would increase to 6,500 MW.[75] Since the Class II increment levels of 1977 CAAA are more restrictive than the Senate and less restrictive than the House versions, the maximum facility size would be between 4,000 and 1,700 MW. This is consistent with the 2,700 MW size that ERT estimated for the actual increment levels of the final legislation, assuming a level of control in compliance with NSPS. The requirement of BACT would allow larger sources to be constructed within the increments.

*A 2,700 MW plant, meeting current NSPS, would not violate Class II increments.*

(ii) Other industrial facilities. EPA has also studied the impact of PSD on the siting of large industrial sources -- including petroleum refineries, Kraft pulp mills, cement plants and copper smelters -- concluding that PSD would result in few or no constraints on siting, in flat or moderate terrains. For example, at least two 1,000-tons-per-day Kraft pulp and paper mills meeting NSPS could be constructed in favorable terrain; in hilly terrain the maximum plant size would be reduced to 600 tons per day, assuming NSPS control levels; additional emission control could increase the maximum size to 1,000 tons per day. Since the typical size for new paper mills is about 1,000 tons per day for new facilities and 400 tons per day for expansion at existing sites, the construction of economically efficient mills would not be prevented.[76]

*Will Class II increments constrain other industrial facilities?*

(iii) Developing energy technologies. The potential constraints on the siting of advanced energy technologies have also been examined. Environmental Research and Technology, Inc. analyzed seven proposed sites for synthetic fuel facilities (high

Btu gasification plants, low Btu gasification plants and oil shale plants), with the general conclusion that the 1976 Congressional version of significant deterioration amendments would not

*A single commercial-size oil shale or gasification plant can be sited within the Class II increments.*

> prevent the construction of economically sized oil shale facilities or gasification plants, ... [although] ... some sources (especially large sources in severe terrain) may have to employ different air pollution control strategies such as further control of sulfur dioxide emissions, construction of taller stacks, incineration of flue gases, or construction at an alternative site.[77]

In flat or moderate terrain, one typical oil shale plant of 50,000 barrels per day or one gasification plant of 250 million standard cubic feet per day would not be constrained by the Class II increments for $SO_2$. Plant sizes in both cases are typical of current planning.

*Information is needed on emissions and abatement strategies for newer technologies.*

Another study[78] examined the possible constraints on coal gasification, coal liquefaction, and oil shale facilities for plants sited in flat terrain. The report concluded that, for the specific processes investigated, the construction of new commercial-sized coal gasification and oil shale facilities would not be restricted by Class II increments of any of the proposed amendments, if careful consideration were given to the choice of sites. Adequate data on emissions were not available to estimate the impact of PSD on coal liquefaction facilities. The control technology assumptions of this study were based on emission limitations adequate to meet NSPS, insofar as such standards exist for newer technologies. (The only NSPS applicable to coal conversion processes apply to the steam boiler used in gasification and liquefaction.) The overall control technology assumptions used were "conjectural and based on... judgment regarding EPA actions and knowledge of control technology limits."[79] The study concluded that additional information on the emissions and the costs of abatement control for new energy technologies, and on the effects of adverse terrain, would be needed to estimate the siting constraints of PSD for developing energy technologies.

*Co-location of Facilities*

*Will increments limit the co-location of facilities?*

The extent to which new major sources of emissions can be located in close proximity depends on the emission limitations achieved and terrain and meteorological conditions. EPA has estimated that, in flat terrain, two new 1,000 MW plants, meeting present NSPS emission limitation levels, would be required to locate approximately 28 miles apart to avoid violation of the Senate Class II short-term $SO_2$ increment (100 micrograms per cubic meter compared to 91 of the CAAA). If one new plant controlled emissions to 1.2 lbs $SO_2$/mm Btu and the second plant emitted 0.6 lb $SO_2$/mm Btu, the required separation distance would be reduced to 14 miles.[80] Hilly terrain would represent the same problem for co-locating facilities as for individual facilities.

*Effects of Class III Designation*

*Class III increments allow for maximum growth.*

Although no area has yet been designated Class III, the 1977 amendments allow such a classification for maximum industrial growth. If new coal-fired power plants control emissions to between 0.12 and 0.46 lb $SO_2$, a 3,500 to 13,000 MW facility could be built in flat or moderate terrain, and a 1,050 to 4,000 MW capacity plant in hilly terrain, within a Class III increment level. Five 1,000 MW plants, achieving similar emission limits, could be built at the same site in moderate terrain, while in hilly terrain two 1,000 MW plants would need to be separated by 8-19 miles.[81]

*Proximity to Class I Areas*

New major sources of emission will be required to locate at some distance from Class I areas in order to avoid violations of the latter's allowable increments. EPA has estimated separation distances for a new 1,000 MW coal-fired power plant, employing FGD on medium-sulfur coal in the East and FGD on low-sulfur coal in the West to achieve emission limitations of from 0.12 to 0.46 lb $SO_2$/million Btu, to be 5-20 miles in flat or moderate terrain and 25-42 miles in hilly terrain. One new 50,000 barrels-per-day oil shale plant would need to site 3 miles away from a Class I area in flat or moderate terrain, and 8 miles away in hilly terrain. Similar distances for a coal gasification plant (250 million standard cubic feet per day), achieving an emission limitation of 0.2 lb $SO_2$/mm Btu, are 7 miles in flat or moderate and 33 miles in hilly terrain.[82] EPA has noted that proximity to a Class I area may not necessarily result in constraints on siting; for example,

*How close to a Class I area can new sources be built?*

> a site-specific analysis of the Four Corners area indicated that the present and projected capacity through 1986 of the Four Corners and San Juan power plants plus the four gasification plants planned by El Paso and WESCO could be built without violating ... the increments in nearby Class I areas.[83]

*Waivers from Class I increments may ease facility siting ...*

The estimate of required separation distances from a Class I area can be significantly altered by the effect of the legislative provision for a Class I "relief" level (which allows a new source to site where its emission would violate the increments for Class I area, if the owner can demonstrate to the satisfaction of the official responsible for the land that the emissions will not adversely affect air quality related values, including visibility), and for a waiver from compliance with the short-term Class I $SO_2$ increments for a maximum of 18 days in any annual period (to be granted only with the concurrence of the official responsible for the Class I area). EPA has estimated that the 18-day waiver provision would allow pollutant concentrations to be two to four times greater than PSD without the waiver provision; maximum plant sizes would be increased commensurately.[84] These increased emissions could reduce visibility and adversely affect the scenic values of national parks and wilderness areas; the desire to protect these values could limit the granting of any relief or variance from Class I increments.

*...but may adversely affect visibility.*

*Modeling for the variances may be difficult.*

The modeling of pollutant concentrations during the preconstruction review process under PSD is particularly difficult in rough terrain, typical of western Class I areas. In areas of flat or moderate terrain, EPA models are generally accepted as reasonably accurate for estimating concentrations up to 30 miles. In rugged terrain, or for greater distances, air quality analysis is less accurate. EPA has noted that modeling for the granting of a variance would be particularly difficult, commenting that while

> present analytic tools ... are capable of estimating concentrations which would result during critical meteorological conditions, they are not well suited for estimating the frequency of occurrence of concentrations.[85]

The actual effect of Class I areas on siting depends on the number and size of the areas designated as pristine, in addition to those mandated in the law, and on the administration of the variance provisions.

*Allocation and Availability of Increments*

*What will happen when increments are used up?*

All the above siting/size analyses have been based on the assumption that an individual new source would have the total allowable increment of pollutant concentration for a particular area available. If increments are allocated on a first-come, first-served basis, at some point increments will be used up, and new facilities seeking to locate in a PSD area may face much the same constraints as in a non-attainment area -- either select another site or convince other sources already allowed in the area to reduce emissions. In addition, development unrelated to major industrial expansion can have an impact on ambient air quality and on allowable increments. Multiple small sources and industries not covered by the 28 categories subject to preconstruction review could use up portions of the incremental pollution load in a PSD area.

*Additional Potential Constraints on Siting*

The extension of PSD increments to the remainder of pollutants covered by NAAQS and the possible expansion of air quality regulations to new pollutants (such as trace metals, radioactive emissions, sulfates, and fine particulates) could result in additional constraints on the siting and scale of new facilities. Emission control technology will need to be either upgraded so that emissions meet stricter standards or adapted to control present unregulated pollutants.

*Air quality is only one factor affecting siting.*

Water quality and water supply will be another consideration in the availability of future sites. Estimates for the various coal conversion technologies, for example, indicate that substantial water will be required both for the conversion process itself and for cooling. Estimates made by the Water Resources Center at the University of Illinois ranged from 5,000 - 22,000 gallons per minute for a high Btu gasification plant; the latter amount is estimated as equivalent to the consumption of a community of approximately 150,000 inhabitants.[86] Water requirements for fluidized-bed combustion, however, have been estimated as less than conventional coal-fired power plants with scrubbers.[87] The entire coal fuel cycle, from mine-mouth to power generation, consumes water. In the West, for example, sprinkling to minimize dust creation in ore handling will place further pressures on the limited water available. Aggregate water requirements for projected energy development may present potential conflicts with other water uses, such as municipal water supply, or irrigation.

Water pollution may become another environmental constraint on energy and industrial development since an optimum location for maintaining air quality may not be desirable for maintaining water quality. Waste water streams from coal-related energy facilities (a result of such activities as cleaning stack gases, removal of coal slurry, and run-off from coal storage) and control strategies available for air quality maintenance have a potential impact on water quality.

## EFFECT ON ALTERNATIVE ENERGY TECHNOLOGIES

*PSD will affect the costs of coal vs. nuclear vs. oil for power generation.*

The cost of complying with increasingly stringent emission limitations, as a result of revisions in NSPS or a BACT requirement under PSD, will significantly affect the economic position of conventional coal combustion technology for power generation in comparison to oil or nuclear. An ICF, Inc. study in 1976 concluded that if all new coal-fired power plants were required to install scrubbers, in some regions new oil plants would be substituted for new coal plants at intermediate load.[88] However, if the National Energy Plan is adopted, its goal of reduced dependence on foreign oil will preclude the construction of any new oil-fired units.

### *Coal in Comparison to Nuclear*

*Nuclear may become a least-cost option, in some areas.*

A 1976 NERA study estimated comparative costs for coal and nuclear generation, in five regions of the United States for varying levels of sulfur dioxide emission limitations. In the absence of any sulfur constraint, coal and nuclear generating costs were found to be similar.

> However, the addition of scrubbers to achieve compliance with NSPS drives up coal costs substantially in the North Atlantic, South Atlantic and in the North Central regions ... making nuclear capacity, on the average, more economically attractive.[89]

The costs of coal and nuclear were roughly equivalent in the West, because adequate supplies of low-sulfur coal, capable of meeting NSPS without scrubbers, resulted in a minimal impact on coal costs. The report concluded that if scrubbers were required on all new plants, coal-fired generation would become less economical in the entire country in comparison to nuclear.[90]

A recent EPRI[91] report analyzed the costs of producing electricity from coal and nuclear power stations, using currently available

*The cost balance depends on emission control requirements for coal combustion.*

technology, for six regions of the country. The study assumed a 1,000 MW coal plant with a flue-gas desulfurization system adequate to meet current (1976) NSPS, and a 1,000 MW pressurized water reactor nuclear plant. The range of levelized busbar costs (1976 dollars), assuming a 1986 installation date, was estimated at 37.5 to 52.8 mills/kWh for coal and 34.0 to 46.4 mills/kWh for nuclear, for the nation as a whole. The study concluded that

> both coal and nuclear can be economically attractive in all regions, depending on specific circumstances; nuclear generation shows an average cost advantage in all regions; average cost positions of coal and nuclear generation are closer in the western part of the country, reflecting the generally lower cost of coal; site specific considerations will have a major effect on cost comparisons between coal and nuclear generation, particularly the availability of low cost coal transportation.[92]

More stringent emission limitations of either revised NSPS or BACT will alter this cost analysis, shifting the balance further in favor of the nuclear cycle. However, the use of nuclear fuel is affected by rising operating and fuel costs, uncertainty about available uranium supplies, and problems with waste disposal. Moreover, the political climate relative to the siting of new nuclear power plants may be an overriding constraint on the switch to nuclear or a coal-nuclear mix.

*Developing Coal Combustion Technologies*

*PSD will encourage the use of technologies with lower emission levels.*

In general, PSD legislation will encourage the development and commercial use of those technologies which have lower emission levels or which have less expensive emission control options. Fluidized-bed combustion (FBC), expected to be commercially available in the 1980's has been estimated as cost competitive with direct coal combustion using a FGD system for baseload or intermediate load operation.[93] FBC offers environmental advantages over FGD systems, such as a dry sludge with easier disposal problems and reduced trace element emissions, but may

*The costs of emission control will affect the economic competitiveness of energy technologies.*

have difficulty meeting increasingly stringent particulate standards. $SO_2$ emissions can be further controlled by adding limestone to the bed, although the disposal problem is aggravated and costs are affected (to what degree is yet undetermined). FBC may also be capable of operating economically at a smaller unit size, facilitating siting within PSD increments. Solvent refined coal, liquefaction, oil shale and gasification may all have difficulty achieving increasingly lower $SO_2$ emission limitations. Magnetohydrodynamics, expected to be commercial in the late 1990's, has significant advantages in improved efficiency, low $SO_2$ emissions and dry waste but may experience problems in meeting particulate or $NO_x$ standards. Emission control methods will need to be developed or improved for these energy technologies; the costs of emission control will affect their commercial competitiveness.

*The development of inherently cleaner technologies will be encouraged.*

*Less Polluting Technologies*

The siting constraints of PSD as a result both of the requirement to locate at some distance from a Class I area and the possible future unavailability of increments will encourage the development and commercial use of technologies which are inherently less polluting. Geothermal energy is a potentially low cost option, although limited to hot,dry rock areas in the West and geopressure resources along the Gulf Coast. Solar technologies appear to be more attractive than many competing technologies in terms of environmental effects. Photovoltaic, ocean thermal and wind energy conversion systems do not discharge heat into the environment and do not have effluent problems inherent in fossil-fuel or nuclear systems. Solar thermal systems, although requiring cooling water, do not have the environmental and safety problems typical of electric power plants. Solar technologies, however, will require larger land areas than other generating technologies.

PSD implementation may encourage measures to use energy more efficiently, especially as PSD increment ceilings are approached. The increased costs of electricity as a result of stringent emission limitations and area classification constraints on siting may encourage a reduction in demand.

EFFECT ON GROWTH

*Industrial and Energy Growth*

*Is PSD a "no-growth" policy?*

Industries, in particular the electric utilities, have argued that PSD is a "no-growth" policy, severely limiting the sites available to new growth, and significantly increasing the costs of constructing new facilities. The availability of allowable increments in air pollution concentration and the need to locate at some distance from a Class I area are noted as constraining sites for future industrial growth, while the costs of emission limitation requirements of BACT are cited as placing a severe economic burden on industries. Proponents of PSD, on the other hand, argue that the BACT requirement of PSD will enable more growth to take place within the clean air resources of the nation -- by limiting the amount of pollution each new facility adds to the ambient air, more sources of emissions can be built within a given increment. Projections of the effect of PSD on development are subject to the latitude allowed the states to redesignate areas and to determine the level of emission limitations in clean air areas.

*EPA says PSD regulations have not constrained siting.*

EPA has noted that, under implementation of its regulations since their promulgation in 1974, numerous industrial facilities have been approved for construction. In evaluating an analysis of potential siting constraints imposed by PSD on 74 planned new utility plants, EPA commented that

> it is important to recognize that the plants considered in the sample were planned in terms of size and location without the framework of a non-deterioration policy ... in the future utility companies could be expected to exercise more judgment in selecting appropriate sites so that they could build plants without violating non-deterioration limits. [94]

Nevertheless, EPA has stated that the Class III designation would probably be necessary in the post-1980 period to avoid significant restrictions and/or altered development patterns by 1990 and to allow large scale development such as industrial or energy parks.[95] The number and size of Class I areas in the western Mountain States, coupled with the difficulties of siting in rugged terrain within allowable increments, may present particular problems for energy development. Increased coal combustion, expansion of energy resource extraction, especially oil shale development, and the siting of a number of gasification and liquefaction facilities have been projected by models of the National Energy Plan to take place largely in the West between 1985 and 2000. An analysis of the effects of NAAQS and energy development in the Rocky Mountain West concluded that present ambient air standards would not seriously impede western coal development, including coal-fired power plants and coal gasification facilities, although major oil shale processing using current facility design would conflict with NAAQS. The report, written before the 1977 Amendments, suggested that a provision for PSD "would constrain the level of coal conversion in several western resource areas before the end of the century."[96]

*PSD may constrain energy development in the western states.*

The long-term effects of air quality management programs such as PSD on industrial and energy growth are uncertain; limitations ot natural resources, other than air, will have significant effects on that time scale. The long-term patterns of demand for industrial and energy growth are also uncertain; the National Energy Plan, for example, postulates that conservation and increased efficiency in the use of energy will significantly reduce the need for energy growth by 1985.

*The long-term effects of PSD are uncertain.*

*Regional Growth*

The implementation of PSD will enable states to have considerable control over the amount of growth within clean air areas through area redesignations. States wishing to encourage development may redesignate as Class III, while states wishing to protect industrie dependent on clean air, such as tourism, may redesignate as Class I. However, since pollution from one state may intrude on another state, conflicts between pro-development states and more environmentally

*States can affect growth by redesignating areas...*

concerned states may develop. For example, the State of Utah has proposed to redesignate 9% of the state as Class I and 44% as Class III, to accommodate oil shale development; a portion of Utah's eastern border with Colorado would become Class III. On the other hand, Colorado is in the process of developing a stringent $SO_2$ standard for much of the state west of the Continental Divide.[97] These conflicting goals will need to be resolved.

*...and by BACT determination.*

In addition to area redesignation, states may affect the amount of growth within the allowable increments of a PSD area by the emission limitation required for a new source. The permitting authority is responsible for determining the best available control technology; a more stringent emission limitation would allow more development within a specific increment limit.

*Will PSD affect regional growth patterns?*

PSD may offset the current incentives for major new industrial growth to locate primarily in the West where there are greater quantities of clean air, if the NAAQS were the only limits to pollutant concentration. It has been argued that, without the limits of PSD increments, "there exists a strong incentive ... for industry to 'shop around' for states or localities with large clean air resources and weak pollution control standards."[98] However, the ability of states to redesignate areas and to determine the degree of emission limitation in areas subject to PSD regulations will not eliminate "shopping around."

One cause of regional differences in growth has been the increased demand for low-sulfur coal as a method of compliance with present NSPS, and the concommitant economic boom in low-sulfur coal regions and economic decline in high-sulfur coal mining areas. The continuous emission control requirements of revised NSPS, and best available control technology required under PSD will preclude the use of untreated low sulfur coal to reduce emissions. This should result in a decreased demand for low-sulfur coal and a reduction in one cause of disparity in regional growth. A recent study[99] of

*BACT and NSPS may alter the demand for low-sulfur coal.*

the effects of BACT on regional coal markets concluded that BACT provisions will have limited effect on coal markets initially but will substantially alter market patterns after 1985. The initial small impact results from the assumptions that plants already under construction with permits to burn western coal will be exempt from BACT and that significant new production in the Midwest region (e.g., Illinois, Indiana, Western Kentucky) will be difficult to achieve before 1985. An amendment to the Clean Air Act of 1977 introduced by Rogers and Metzenbaum,[100] authorizing the President to require a utility to burn local coal in cases of unemployment or economic dislocation, may have an additional influence on coal production patterns.

## VI. OPTIONS FOR THE DEPARTMENT OF ENERGY

*DoE needs to consider health and environmental aspects of energy development.*

All energy policy options open to DoE require consideration of the health and environmental aspects of technology development and deployment. This is required by law and is an integral part of DoE's programs. PSD can be expected to affect DoE's RD&D programs in three ways: 1) accelerating development of those fossil-fuel technologies which have lower emission levels or can achieve emission limitations at lower cost; 2) encouraging development of emission control technology, including control as a part of the process; and 3) increasing the importance of the development of alternative fuel cycles that are inherently cleaner. In response to these effects, DoE can adopt different strategies:

*Option 1*

*DoE might continue energy RD&D programs, treating environmental policies as a constraint.*

DoE can continue with the energy RD&D programs begun by ERDA, basing future decisions on energy demand projections and cost-benefit-risk analysis, treating PSD as a constraint only when the legislation affects a particular proposed facility or developing technology. It is possible that this strategy will lead to the most rapid and least-cost development of new energy technologies: effort is focused on the technological questions, environmental considerations are settled by EPA regulations, and acceptance is determined by the market place. DoE might seek administrative or legislative relief from compliance with certain standards if they would inhibit development or deployment of new technologies. This option may be least expensive in the short-run but may not be cost-effective if programs need to be redirected or even curtailed after major commitments have been made as a result of PSD enforcement.

*Option 2*

DoE can maintain its current RD&D rationale but make a more constructive move towards incorporating environmental goals into energy technology development by:

- Monitoring the development of PSD implementation, such as regulatory interpretation, states' standard setting and area classification, and possible court decisions, to acquire information on environmental and regulatory problems. Particular interpretations,such as the allocation of increments on a first-come, first-served basis, might be addressed.

• Analyzing all developing technologies for their emissions of pollutants presently regulated or likely to be regulated under PSD; studying the potential for control technologies for these pollutants; and estimating the likely incremental costs. The Environmental Development Plan will provide much of this information.

*DoE might prepare summaries of BACT determinations.*

• Preparing an on-going summary of BACT determinations and the associated costs, as they occur in PSD reviews. BACT requirements will have important implications for the commercial competitiveness of developing technologies.

*DoE might develop forecasts of the future availability of increments.*

• Addressing the possibility that certain sites may become unavailable in the future as PSD increments are used up by examining, for example, background levels of pollutants, topography, and area designation, or by forecasting the availability of increments in the next 10-15 years. Additional requirements of water and transportation, as well as additional air quality constraints, may further limit the sites available.

• Examining the interrelationship of PSD, non-attainment requirements and revisions in the NSPS in order to evaluate the overall impact of environmental regulations on energy development and facility siting. A comprehensive, national survey of regions that are subject to single or multiple legislative requirements might be developed.

• Expanding research into improved emission control technologies for conventional combustion technologies, such as regenerable scrubber systems, coal preparation on a more intensive level, or combinations of coal preparation with flue gas desulfurization systems.

• Developing abatement strategies for smaller facilities, not covered by new source review procedures. Excessive emissions from such sources might use up increments and constrain growth.

• Expanding research into the development of reliable air quality measuring and monitoring techniques. Both monitors and models are essential in the implementation of PSD.

*DoE might consider redirecting program goals.*

• Redirecting some program goals from coal towards nuclear and/or renewable sources. If the impacts of PSD on industry and utilities promise to be sufficiently large as to cause fuel switching on a significant scale, then DoE might wish to accelerate development of solar energy, geothermal energy and other less polluting technologies, and direct increased effort towards technologies for conservation and for improving energy efficiency to reduce demand and the potential environmental loading of pollutants.

*Option 3* (including all of Option 2)

*DoE might initiate research on the health and environmental effects of new technologies.*

DoE can attempt to anticipate possible future increases in environmental constraints, such as more stringent PSD regulations, by increasing current support for environmentally-oriented programs or by initiating new research programs and analyzing the detrimental or advantageous health and environmental effects of new technologies. Research related to the effects of coal combustion could be expanded, in order that major RD&D decisions could be made on the basis of environmental performance above and beyond existing regulations.

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## APPENDICES

A. Workshop on the Probable Impacts of the Prevention of Significant Deterioration Amendments to the Clean Air Act on ERDA's Programs.

B. Annotated Bibliography of Studies of the Prevention of Significant Deterioration.

APPENDIX A

## Workshop on the Probable Impacts of the Prevention of Significant Deterioration Amendments to the Clean Air Act on ERDA's Programs

## I. AGENDA

Monday, January 24

9:00 - 12:30 - Plenary Session

Opening Remarks:
George Leppert
Office of Environmental Policy Analysis, ANL.

Discussion of Agenda and Meeting Objectives:
John Gibbons, Chairman
Environment Center
University of Tennessee

ERDA's Policy Interest in PSD Legislation:
Joseph A. Coleman, Acting Director
Office of Environmental Policy Analysis, ERDA.

ERDA's Environmental Review and Assessment Process:
Ellison Burton
Office of the Ass't. Adm. for Planning & Analysis, ERDA.
Benjamin Schlesinger
Office of Fossil Energy, ERDA.

Background of PSD Regulations:
Thomas F. Schrader
Division of Policy Planning
Environmental Protection Agency

Analysis of PSD Impacts:
James Mahoney, Vice-President and Technical Director
Environmental Research & Technology, Inc.

Environmental Viewpoint:
Lawrence Moss
Environmental Consultant

12:00 - General Discussion

12:30 - 1:30 - Lunch

1:30 - 2:00 - Plenary Session -- formation of sub-groups

2:00 - 4:30 - Meeting of sub-groups to define scope, organization and final product.

4:30 - 5:30 - Plenary Session --report from sub-groups

8:00 - 10:00- Meeting of sub-groups -- work on issue papers

Tuesday, January 25

9:00 - 9:30 - Plenary Session

9:30 -12:30 - Meeting of sub-groups -- complete issue papers

12:30 - 1:30 - Lunch

1:30 - 5:00 - Plenary Session

1:30 - Final Reports from sub-groups

2:30 - Discussion of reports

3:30 - Presentation and discussion of crosscut issues

## II. SUMMARY

ERDA requested Argonne's Office of Environmental Policy Analysis to investigate the potential effects of the Prevention of Significant Deterioration Amendments to the Clean Air Act on ERDA's energy research and development programs. An initial review of existing studies indicated a considerable diversity of opinions. Before launching another independent study, a workshop was held to assist in identifying the most important questions for further investigation.

The workshop, held on January 24-25, 1977, at Airlie House in Virginia brought together participants from Federal agencies, including ERDA, EPA and FEA; staff members of the House Committee on Public Works and of the Congressional Research Service; and representatives of those groups most actively involved in either supporting or opposing the prevention of significant deterioration concept. The latter groups included the electric utilities industry, independent firms that conduct engineering and economic studies for the utilities and for Federal agencies, and environmental interests. John H. Gibbons, Director of the Environment Center of the University of Tennessee, chaired the workshop.

The opening plenary session set the stage for the workshop by briefly examining PSD regulations, their general impacts and benefits, and the reasons for ERDA's interest in PSD legislation. Following opening remarks by George Leppert, Director of Argonne's Office of Environmental Policy Analysis, John Gibbons presented the objectives of the workshop -- to help define the likely overall impacts of PSD on ERDA's plans, programs and priorities. Joseph Coleman, Acting Director of ERDA's Office of Environmental Policy Analysis, briefly described the program in policy analysis and sketched ERDA's concern with PSD and its potential effect on national energy development. Ellison Burton, of ERDA's Office of Planning and Analysis, described the agency's environmental review and assessment process; he described a new instrument, the Environmental Development Plan, which will incorporate environmental considerations early into the planning process for a new energy technology. Benjamin Schlesinger, of ERDA's Office of Fossil Energy, sketched the energy technologies program of that office. Thomas Schrader, of EPA's Division of Policy Planning explained EPA's present regulations covering PSD and the proposed approaches to significant deterioration discussed in the 94th Congress. James Mahoney, of Environmental Research and Technology, Inc., described the analysis his organization had conducted of the siting and scale impacts of PSD on electric utilities. Lawrence Moss, President of the Sierra Club when that organization sued EPA for failing to prevent the significant deterioration of air quality, explained the environmental view of the health and welfare benefits of PSD and of the deficiencies of the EPA regulations and proposed Congressional amendments.

Following the opening session, the participants in the workshop separated into five sub-groups to formulate the issues related to the potential impacts of PSD on ERDA's programs. The sub-groups were asked to initiate recommendations of specific areas of analysis that ERDA should address. The first group discussed economic impacts of PSD, considering such topics as the capital and operating costs of compliance, the costs of non-optimum siting, and regional cost implications. The second group addressed economic issues concerning PSD impacts on energy demand and the demand for fuel. The third group considered the capabilities of present control technologies for achieving compliance with PSD regulations. The fourth group examined environmental issues, such as pollution from alternative energy technologies. The fifth group dealt with the implementation of the regulations and the potential ways environmental consideration can be incorporated into ERDA's policy decisions on research.

All participants were urged to identify and consider important issues which fell outside the purview of any of the five sub-groups.

The sub-groups discussed the issues, drafted reports summarizing important questions and reported the results in a final plenary session. The reports of the sub-groups and both formal and informal discussions identified the areas of potential impacts of PSD on ERDA programs that needed investigation and, in many cases, provided further exposition of those areas. The present report draws on the results of the workshop and subsequent comments by a number of the participants.

Some of the conclusions reached in the last session of the workshop were:

(i) PSD needs to be considered in the context of its place in the air pollution and air quality maintenance field.

(ii) The national objective of improved environmental quality is an evolving one. Thus ERDA needs to be not only responsive to existing public policies in this area (e.g., developing ways to improve the cost-effectiveness of emission control, provide alternative fuel systems, and increase efficiency in both supply and utilization) but also responsible (along with EPA and other agencies) for anticipating possible new problems (e.g., additional pollutants needing control) and evaluating potential ways to deal with them.

(iii) ERDA needs to help evaluate ways to improve the net benefit of alternative PSD control criteria, for example, illuminating the advantages and disadvantages of specifying maximum pollution levels for longer time intervals than a few hours, which may overemphasize occasional short-term effects.

(iv) ERDA could make valuable contributions to improved monitoring and analysis methods and to evaluating air quality regulations associated with energy conversion.

## III. SUB-GROUP TOPICS

All sub-groups are asked to discuss the following:
What are the probable effects on ERDA programs of PSD legislation?
What specific R&D questions related to your sub-group topics should ERDA address?

1. Economic Impacts

   - direct economic consequences of PSD legislation--required capital and operating expenditures needed for compliance.
   - indirect costs -- non-optimum siting, loss of economies of scale, co-location, cogeneration, etc.
   - regional cost implications.

2. Supply and Demand (Energy & Fuel)

   - impacts of PSD on energy demand; potential for conservation; effects of regulations on development of conservation technology.
   - energy required for control.
   - demand for fuel -- fuel mix changes due to regulations (are supplies sufficient?); effects on coal combustion, strip mining, coal gasification, etc.

3. Control Technology

   - current performance characteristics of control devices (BACT, RACT): outlook for future control technologies, costs.
   - technological areas in need of R&D.
   - incentives for new control technologies.
   - supply of control equipment.
   - emissions from non-energy supply sources.

4. Environmental Impacts

   - environmental impacts from alternative technologies to meet PSD requirements-- water pollution from sludge, and land required for waste disposal, etc.

- health effects from alternative technologies.
- other pollutants not covered in PSD regulations.
- analytical tools needed to calculate impacts-- models, cost-benefit analysis, etc.

5. Implementation

- need for additional monitoring, baseline data.
- non-market aspects -- taxes, regulations, future legislation, etc.
- effect of PSD on areas of non-attainment of standards.
- position of environmental planning, assessment and policy analysis in ERDA program planning and implementation.

SUB-GROUP MEMBERS

1. Economic Impacts

   R. Bohm, Rapporteur
   E. David Daugherty
   D. Fink
   L. J. Perl
   T. F. Schrader, Chairman
   C. Hoff Stauffer, Jr.
   J. Speyer

2. Supply and Demand (Energy & Fuel)

   S. B. Baruch, Chairman
   R. Holt, Rapporteur
   E. Houghland
   B. Schlesinger

3. Control Technology

   D. K. Berry
   K. M. Hargis
   S-L. Kung, Rapporteur
   R. M. Perhac, Chairman
   R. Reeves
   J. Siegel

4. Environmental Impacts

E. S. Burton

B. Goldsmith, Chairman

M. Grimes, Rapporteur

T. Koss

D. Lieberman

R. Morris

H. Slater

M. D. Williams

5. Implementation

B. Brown

J. A. Coleman, Rapporteur

C. Lundberg, Chairman

J. R. Mahoney

L. Moss

H. Whiteside

K. R. Woodcock

## IV. LIST OF PARTICIPANTS

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# APPENDIX B

## Annotated Bibliography of Studies of the Prevention of Significant Deterioration

Biniek, Joseph P. and Maria H. Grimes, Air Quality: Prevention of Significant Deterioration. Library of Congress, Congressional Research Service, Issue Brief No. IB74037. March 9, 1977.

This issue brief on air quality with emphasis on the prevention of significant deterioration concept covers legislation in 1976 and 1977, hearings, reports and Congressional documents, and a chronology of events. Also included are summaries of arguments by the Sierra Club, utility industries and states on the necessity of legislation to prevent significant deterioration and the deficiencies of proposed regulations.

Brown, B. D. and C. S. Lipaj, Implications of a Prevention of Significant Deterioration Policy on State Growth Management. Environmental Protection Agency, Washington, D. C., Report 76-13.2, 1976.

This report describes the three alternative significant deterioration regulations proposed by Senate, House and EPA and their approaches to the identification and reclassification of areas in terms of the impact on state land use policies. Under the proposed legislation, states will be required to protect their clean air areas and limited air resources. There will be incentives and requirements for the states, in cooperation with local governments, to take the lead in determining how much, how fast and where major growth should occur.

Department of Commerce, Bureau of Domestic Commerce, Office of Business and Legislative Issues, An Analysis of the Impact of Alternative Approaches to Significant Deterioration in the Non-Ferrous Metals Industry. Staff Study A-03-76. April, 1976.

This study was undertaken to determine to what extent the additional requirements of non-deterioration (EPA regulations and 94th Congress proposed legislation) would prevent the industry from necessary expansion and construction of new production facilities, even under conditions of otherwise full compliance with the existing State Implementation Plans and New Source Performance Standards pollution control requirements.

----- Studies on Non-Deterioration of Air Quality: An Annotated Bibliography. May, 1976.

In May 1976, the Department of Commerce compiled an annotated bibliography on significant deterioration from 17 major studies. Industrial sources studied by the non-deterioration analyses include coal mining, fossil-fuel boilers, fossil-fuel fired steam electric plants, fuel conversion plants, Kraft pulp and paper mills, oil refineries, petroleum refineries and non-ferrous metal industries. The four common conclusions are: (1) Class I areas appear to be a major obstacle to economic growth; (2) capital costs are increased; (3) non-deterioration will favor smaller plants, additional control technology, taller stacks, and relocation of plants; and (4) future growth will be restricted unless a Class III designation is provided.

Edison Electric Institute, Air Quality Report (Background Material for the Air Quality Subcomittee Meeting). Environment and Energy Committee, January, 1977 meeting.

The background material contains (1) possible air pollution activities 1977-1980 (federal government, state government, air pollutants); (2) the issue of growth (a. non-attainment area and significant deterioration regulations; b. air quality maintenance planning and Area Wide Water Quality Management Program 208 planning); (3) a summary of EPA's draft sulfate research plan; (4) a review of EPA's New Source Performance Standards; (5) Clean Air Act Amendments of 1976 (review of Conference Report); (6) pollutant standards index; and (7) EPA's coal conversion approvals.

Energy and Environmental Analysis, Inc., Review of the Impact of the Clean Air Act Amendments on ERDA-FE Projects. Arlington, Va. August 16, 1976. (Prepared for ERDA, Office of Fossil Energy).

This report assesses whether the proposed House and Senate provisions of the Clean Air Act Amendments are likely to restrict the scale or affect siting decisions for commercial coal and oil shale conversion technologies. The report includes a description of the methodology, key features of the proposed House and Senate amendments, and data summarization. Conclusions and recommendations for future work are discussed.

Environmental Protection Agency, Technical Support Document: EPA Regulations for Preventing the Significant Deterioration of Air Quality. January, 1975.

This document provides a detailed discussion of the technical and policy considerations which form the basis for EPA's regulations for prevention of significant air quality deterioration (published on December 5,1974, in Federal Register 39 42510). A summary of each major issue is presented as well as references to more detailed materials which have been prepared on that issue.

----- A Preliminary Analysis of the Economic Impact on the Electric Utility Industry of Alternative Approaches to Significant Deterioration. February 5, 1976.

The economic costs to the electric utility industry resulting from the 1975 Senate and House non-significant deterioration proposals are examined. Three scenarios are investigated: base case, nuclear moratorium and energy conservation. This report is termed a preliminary assessment because it is subject to: (1) further refining the analysis in specific areas; (2) changes by the Congressional committees; and (3) coordinating the findings of this study with 2nd Project Independence report.

Environmental Protection Agency, Summary of EPA Analysis of the Impact of the Senate Significant Deterioration Proposal. April, 1976.

This report summarizes the analyses that EPA and its consultants have conducted on the specific impacts of the Senate Bill (S. 3219) on selected major industries, including electric utilities, Kraft pulp and paper, refineries, synthetic fuel plants and copper smelters. The conclusion includes impacts on facility location, size, buffer distance from Class I area, minimum separation distance between plants, capital and annual operating costs that would result from the Senate version of prevention of significant deterioration.

----- Summary of EPA Analysis of the Impact of the House Significant Deterioration Proposal. May 24, 1976.

This report summarizes a series of analyses that EPA and its consultants have conducted on the specific impacts of the House Bill (H.R. 10498) on selected major industries, including electric utilities, Kraft pulp and paper, refineries, synthetic fuel plants, and copper smelters. The conclusion includes impacts on facility location, size, buffer distance from Class I area, minimum separation distance between plants, capital and annual operating costs that would result from the House proposal of prevention of significant deterioration.

----- Technical Studies for Assessing the Impact of Significant Deterioration Regulations. May, 1976.

This document presents the results of detailed technical analyses that EPA and its consultants have conducted on the impacts of significant deterioration regulations on five major industries: electric utilities, pulp and paper, refineries, synthetic fuels, and copper smelting. These industries were selected because they are often sited in clean air areas and are generally large sources of pollutants. Conservative meteorological dispersion modeling was used to calculate ground-level pollutant concentrations that would result from typical facilities. These data provide a suitable basis for assessing:

1. The size of major industrial facilities that can be built under Class II (or Class III) increments.
2. The effect on the spacial distribution of major industrial facilities under Class II (or Class III) increments.
3. The required "buffer" distance from Class I areas for major industrial facilities.
4. The effect of different levels of emission control on the size and siting of major industrial facilities.

Environmental Protection Agency, An Analysis of the Impact of Alternative Significant Deterioration Proposals on the Kraft Pulp and Paper Industry, June 4, 1976.

The impact of alternative non-significant deterioration proposals on future Kraft industry expansion is analyzed using historical and projected data through 1978, in the absence of the actual data of new mills and capacity expansions. Three capacity scenarios were examined: (1) actual new mill and expansion capacities 1971-1978, (2) duplication of total site capacity including existing and new announced expansions, and (3) the construction of a prototype 1000 tons per day bleached Kraft mill at each of the sample sites. In addition, the cost impact of best available technological control requirements was assessed for projected capacity from 1980 to 1990.

----- Critique of FEA's Analysis of the Impact of the House and Senate Clean Air Act Amendments. June 1, 1976.

This paper discusses studies on the impact of the Congressional Clean Air Act Amendments prepared for the Federal Energy Administration by two consultants -- ICF, Inc. and Environmental Research and Technology, Inc. The specific issues addressed are economic impact (including the impact on oil consumption) of significant deterioration, impact of the proposed non-attainment amendments, and impact of significant deterioration on the surface mining of western coal.

----- Briefing on Impact of Significant Deterioration. July 20, 1976.

This EPA briefing studies three alternative approaches (EPA, Senate and House) to significant deterioration, and their impacts on the electric utility industry, Kraft pulp and paper mills, refineries, synthetic fuel facilities, and copper smelters. The briefing covers (1) maximum size facilities that can be constructed, (2) feasibility of co-locating major industrial sources, (3) required separation distance from Class I areas, and (4) economic impact.

----- Alternative Policies for the Prevention of Significant Deterioration and Related Policy Issues. 1976.

This attachment to the EPA briefing describes the three alternative policies (EPA, Senate and House) for the prevention of significant deterioration. The differences among the three versions are (1) the emitting sources, (2) pollutants and their allowed increments, (3) area classifications, (4) control technology requirements, (5) maximum allowable concentration, and (6) allowable stack height.

----- Summary of EPA/FEA Analysis of the Impact of the House and Senate Significant Deterioration Proposal on the Synthetic Fuel Industry. July, 1976.

This summary lists the maximum allowable plant sizes and their distances from Class I area (according to the 1976 Senate and House versions of significant deterioration) for proposed high Btu gasification plants in New Mexico, Wyoming and North Dakota; for proposed low Btu gasification plants in Illinois and West Virginia; and proposed oil shale plants in Colorado and Utah.

Environmental Protection Agency and Federal Energy Administration, An Analysis of the Impacts on the Electric Utility Industry of Alternative Approaches to Significant Deterioration. October, 1975. Volume I: Executive Summary. (Joint publication by EPA and FEA).

The analysis investigates the possible impacts of the EPA, Senate, and House significant deterioration approaches on the electric utility industry. The analysis is described as preliminary but nonetheless indicative of the range of impacts that could result from alternative significant deterioration approaches.

----- An Analysis of the Impact on the Electric Utility Industry of Alternative Approaches to Significant Deterioration. October, 1975 Volume II: Technical Support Document. (Joint publication by EPA and FEA).

This analysis evaluates the impacts on the electric utility industry of the various approaches to preventing significant deterioration of air quality, specifically, estimating the impact on power plant siting and size of EPA regulations and of the proposals by the Senate and House subcommittees.

----- Analysis of House Discussion Draft dated October 16, 1975. November, 1975. Supplement Report 2. General Edition. (Joint publication by EPA and FEA).

This Supplement Report has been prepared in two versions: a Congressional Edition, and a General Edition. The Congressional Edition is specifically responsive to the work contained in the legislative proposal identified in the title. The General Edition includes the Congressional material, but also addresses the scenario of Environmental Protection Agency regulations in effect under the Clean Air Act as documented in the original report Volumes I and II.

Environmental Research & Technology, Inc., An Evaluation of Proposed Regulations on the Prevention of Significant Deterioration of Air Quality: Implications for New Power Plants and Other Point Sources of Air Pollution. July 14, 1975.

In order to estimate the limitation on new facility size (in Class II regions) which would result from imposition of PSD regulations contained in Senate Working Print No. 3 (August 8, 1975) model calculations were made for coal-fired electric power plants, using design parameters, meteorological conditions and terrain which are typical for the states of New Mexico and West Virginia.

Environmental Research & Technology, Inc., Proposed Clean Air Act Amendments: Implications of Non-Deterioration Rules on Maine. Concord, Mass. August 28, 1975. ERT document #P-1992. (Prepared for the American Paper Institute.)

This report presents an evaluation of the impact on Kraft pulp and paper mills, and coal-fired power plants in Maine that would result from the proposed rules for air quality maintenance planning and PSD as contained in Senate Staff Working Print No 3, dated August 3, 1975. The EPA/CRSTER model is applied to model plants to predict the impact on ambient air quality under various plant parameters, meteorological conditions and terrain.

---- Proposed Clean Air Act Amendments: Implications of Proposed Rules for Non-Deterioration of Air Quality on the Construction of Kraft Pulp and Paper Mills. Concord, Mass. ERT document #P-1967. September 9, 1975. (Prepared for the American Paper Institute.)

This report presents an evaluation of the implications of proposed PSD rules (Senate Staff Print No. 3, August 8, 1975) for the construction of Kraft pulp and paper mills. The EPA/CRSTER model with actual terrain and meteorology is applied to predict the impact of plant emissions on ambient air quality. The limitations of Class II increments and the "buffer zone" from Class I regions are examined.

---- Impact of Significant Deterioration Proposals Upon Western Surface Coal Mining Operations. May 5, 1976. (Prepared for FEA, Office of Environmental Programs, Conservation Paper #52.)

This report addresses the impact of the proposed Clean Air Act Amendments of 1976 upon western surface coal mining. The investigation covers, in particular, the constraints upon coal strip mining activities which might arise because of fugitive dust emissions and the limitations on incremental concentrations of total suspended particulates.

---- Impact Assessment of Significant Deterioration Amendments to the Clean Air Act on Siting of Synthetic Fuel Plants. May 21, 1976. Draft. (Prepared for FEA.) ERT document #P-2125-300.

The discussion in this report constitutes an exploratory investigation to relate predicted ambient air quality concentrations resulting from synthetic fuel plant emissions to increments of air quality degradation proposed by Congress.

Environmental Research & Technology, Inc., Technical Evaluation of the Non-Deterioration Portions of Proposed Clean Air Act Amendments, February, 1977. ERT Document #P-1946-1. (Prepared for the Electric Utility Industry Clean Air Coordinating Committee).

This report presents a technical analysis of provisions for the prevention of significant deterioration of air quality in the proposed Clean Air Act Amendments, as contained in the Conference Report. The specific objectives of this study are: (1) determination of the allowable maximum sulfur dioxide emissions under various assumptions; and (2) evaluation of the interrelated elements of the Conference Bill which would impose additional constraints on electric generating facility development.

----- The Impact of Significant Deterioration Proposals on the Siting of Electric Generating Facilities - Documentation of Analyses Undertaken Between July 1975 and September 1976. ERT Document #P-1946-2. February, 1977. (Prepared for the Electric Utility Industry Clean Air Coordinating Committee).

This is a compilation of material on the siting of electric generating facilities under various significant deterioration proposals.

Federal Energy Administration, Further Analysis of House Discussion Draft Dated October 16, 1975. November, 1975. Supplement Report 3, preliminary draft.

This Supplement Report 3 is a continuation of impact studies of House PSD (H.R. 10498) jointly conducted by EPA and FEA. Modifications have been made to the procedures and methodology which relate to power plant size (650 MW for capacity addition, 830 MW for new planned capacity, and 1350 MW for total site capacity) and alternative BACT definitions (NSPS/SIP and NSPS/FGD).

Federal Register, Prevention of Significant Air Quality Deterioration: Proposed Rulemaking. Volume 38, No. 135, Part IV (18986-19000), July 16, 1973.

This is a proposed rulemaking on prevention of significant air quality deterioration as a result of the Sierra Club suit. It presents a description of (1) alternative definitions of significant deterioration, (2) pollutants subject to controls, (3) sources subject to review, (4) best available control technology, and (5) baseline for measuring deterioration.

----- Air Quality Implementation Plans: Prevention of Significant Air Quality Deterioration. Volume 39, No. 235, Part III. (42510-42517), December 5, 1974.

The EPA promulgated regulations of prevention of significant air quality deterioration. Public comments and changes in the previous proposed regulations are discussed.

Federal Register, Approval and Promulgation of Implementation Plans: Prevention of Significant Air Quality Deterioration. Volume 40, No. 114, Part I (25004-25011), June 12, 1975

This EPA notice contains certain minor amendments to the PSD regulations promulgated on December 5, 1974 (39 FR 42510-42517).

----- Requirements for Preparation, Adoption, and Submittal of Implementation Plans, Prevention of Significant Deterioration, 40 CFR Part 51, Nov. 3, 1977. (Also in 42 FR 57459.)

This proposed rule outlines the new PSD requirements, as required by the Clean Air Act Amendments of 1977, which are to be incorporated by the States into their implementation plans.

----- Approval & Promulgation of Implementation Plans, 42 FR 57479, Nov. 3, 1977.

Proposed rules are presented to amend EPA's PSD regulations to incorporate new requirements of Sections 160-169 of the Clean Air Act Amendments of 1977, amending Section 52.21 CFR.

----- Requirements for Preparation, Adoption and Submittal of Implementation Plans, 42 FR 57471, Nov. 3, 1979.

Proposed rules are presented for revising Section 51.24 of CFR to cover PSD.

Frederick, Franklin P., An Estimate of the Impact of Significant Deterioration Regulations on the U.S. Refining Industry and Related Industrial Growth, January 19, 1975. (Prepared by Bonner & Moore Associates, Inc. for The American Petroleum Institute).

This is an analysis of the impact of the significant deterioration proposal contained in Senate Working Print No. 6, December 22, 1975, on petroleum refining and oil shale processing. This report presents the estimates of limitation on refining growth and the compliance cost that would result from the significant deterioration proposal.

Grimes, Maria H., Side-by-Side Comparison of Provisions of H.R. 10498 and S. 3219, Proposed Clean Air Act Amendments of 1976. Library of Congress, Congressional Research Service. July 21, 1976. Excerpt Sept. 20, 1976.

In this summary presentation, sections of the Senate Bill, S. 3219, are compared to corresponding sections of the House Bill, H.R. 10498. In developing this comparison, edited versions of summaries in House and Senate Reports on the Clean Air Act Amendments of 1976 (Numbers 94-1175 and 94-717, respectively) and summarized versions of floor amendments, approved by House and Senate respectively, were used.

Grimes, Maria H., Strategic Issues in Air Pollution Control and Air Quality Maintenance. Library of Congress, Congressional Research Service. April 18, 1977. Report #77-106EP.

This report examines the validity of existing standards for the protection of health and welfare, the capability of monitors and the accuracy of monitoring data, the possible constraints on growth of non-attainment areas, and the prevention of significant deterioration.

Grimes, Maria H., and John E. Blodgett, Side-by-Side, Section-by-Section Comparison of H.R. 6161 and S. 252 and the Conference Report on S. 3219. Library of Congress, Congressional Research Service. July 12, 1977.

Edited versions of summaries in the House and Senate reports of the Clean Air Act Amendments of 1977 (#95-294 and 95-127, respectively) are used. House Report #94-1742 was used to develop the Conference Report summary.

Hamby, James I.,"The Clean Air Act and Significant Deterioration of Air Quality: The Continuing Controversy." Environmental Affairs, Volume V, #1, Winter, 1976, pp 145-174.

This article reviews the history of the prevention of significant deterioration in Congress and the courts and discusses EPA's regulations. The author concentrates on legal interpretation of the Sierra Club decision and of the Clean Air Act.

ICF, Inc., Issues and Impacts Associated with Proposed Prevention of Significant Deterioration and Non-Attainment Amendments to the Clean Air Act. June 25, 1976. (Prepared for FEA).

This report presents the findings of an analysis of the effects of proposed prevention of significant deterioration and non-attainment amendments to the Clean Air Act, assessing the effects on the coal and electric utility industries. The report includes a PIES analysis of the effects of proposed amendments on key energy variables, an analysis of the effects on the siting of major emitting facilities, and the effects of non-attainment areas.

Johnson, Lou, D.B. Joseph, Charles Stevens and John T. Dale, Prevention of Significant Deterioration of Air Quality: A Western Viewpoint. USEPA: Denver, Colorado. Prepared for presentation at the 70th Annual Meeting of the Air Pollution Control Association, Toronto, June 20-24,1977.

This is a summary of activities since February, 1976, in Region VIII reviewing applications for permits to construct under EPA's PSD regulations. A discussion of difficulties encountered in determining BACT is included in the paper.

Perl, Lewis J. and Thomas K. Fitzgerald, An Analysis of the Costs to the Electric Utility Industry of House and Senate Significant Deterioration Proposals. National Economic Research Associates, Inc., New York. December 12, 1975.

This study evaluates the costs of $SO_2$ control to the electric utility industry for alternative policy options found in the House (October 8, 1975) and Senate (September 4, 1975) proposals. The EPA proposal is not considered explicitly.

Perl, Lewis J., Estimated Costs for the Electric Utility Industry of Non-Significant Deterioration Amendments Currently Considered by the United States Senate. National Economic Research Associates, Inc., New York. April 16, 1976.

This report assesses the economic impact on the electric utility industry of the Clean Air Act as it exists to date and of those changes in the Clean Air Act proposed in S. 3219.

----- Impact of Non-Significant Deterioration Legislation on the Coal/Nuclear Cost Balance and Estimates of the Cost Effectiveness of Alternative Clean Air Legislation. National Economic Research Associates, Inc., New York. May 4, 1976. (Memo to the Electric Utility Industry Clean Air Coordinating Committee).

This is a summary of NERA studies of the impact of Clean Air legislation on the coal/nuclear cost balance and the examination of the cost effectiveness of alternative Clean Air legislation in reducing sulfur dioxide emissions.

----- Assessing the Economic Impact of Non-Significant Deterioration. (Prepared for the OEP/ANL January 24-25 workshop). Unpublished. National Economic Research Associates, Inc., New York. Available from OEP/ANL.

The methodology for assessing the impact of air pollution control legislation (PSD) is described. The estimates of the economic costs of emission regulations include (1) sample plant selection, (2) feasible strategies, (3) linear programming for estimating least cost, and (4) estimation of total capital and operating and maintenance costs of compliance. The report also discusses uncertainties and deficiencies of the methodology.

Perl, Lewis J. and Thomas K. Fitzgerald, Estimated Costs for the Electric Utility Industry of Non-Significant Deterioration Amendments Currently Considered by the United States House of Representatives. National Economic Research Associates, Inc., New York. July 15, 1976.

This report assesses economic impacts on the electric utility industry of proposed non-significant deterioration amendments contained in H.R. 10498. The impacts assessed include the effect of this legislation on the industry's capital, revenue and coal requirements over the period 1975 to 1990. In addition to assessing national impacts, the report evaluates impacts of these amendments on costs in each of nine geographic regions. For comparative purposes, this report also includes an assessment of the impacts of the Clean Air Act in the absence of these amendments.

Perl, Lewis J. and John H. Wile, Costs and Economic Impacts of Proposed Non-Significant Deterioration Amendments to the Clean Air Act. National Economic Research Associates, Inc., New York, March 8, 1977. (Prepared for the Clean Air Coordinating Committee of Edison Electric Institute.)

This report assesses the costs to consumers and other economic impacts of the non-significant deterioration amendments proposed in the Conference Report, the House Bill (H.R. 10498), the Senate Bill (S. 3219), and the rules initially proposed by EPA. The report describes the annual and cumulative impacts of the PSD legislation on consumer expenditures for electricity and on the capital and energy requirements associated with electric generation. The report also describes the decreases in sulfur dioxide emissions and the cost per pound of sulfur dioxide removed for the PSD legislation and for the Clean Air Act Amendments of 1970.

Radian Corp., An Analysis of the Impact on Refinery Siting of Proposed Approaches to Significant Deterioration. August 5, 1976. Draft. (Prepared for EPA, Energy Policy Group.) Report #RC 100-119.

The study analyzes the impact of the proposed ambient concentration increments contained in the Senate and House bills on preventing significant deterioration on the ability to build new refineries, and to co-locate refineries and coal-fired power plants.

Stern, Arthur C., "Prevention of Significant Deterioration: A Critical Review," APCA Journal, Vol. 27, No. 5, May, 1977. pp 440-53.

An extensive survey of the legislative and legal aspects of PSD is presented. The growth of the concept and its implementation are reviewed.

Terris, B. J., N. V. Black and M. Williams, Implications of Preventing the Significant Deterioration of Air Quality: Environmentalists' Issue Paper. 1976 Draft Paper. Unpublished. Available from OEP/ANL.

This paper presents several environmentalists' view of the prevention of significant deterioration. The paper discusses and criticizes the regulations considered by the 94th Congress, and includes recommendations for substantially modifying these proposals.

Terris, B.J., H.C. Needham, S.T. Keiner, N.V. Black and J.W. Moorman. William D. Ruckelshaus, Administrator of the Environmental Protection Agency, Petitioner, v. Sierra Club, et al. In the Supreme Court of the United States October Term, 1972. No. 72-804.

This is the document of the court suit of the Environmental Protection Agency vs. Sierra Club which led to the promulgation of prevention of significant deterioration regulations.

Tennessee Valley Authority, Effects of Prevention of Significant Deterioration Regulations on the TVA Power System. (Prepared for OEP/ANL January 24-25 workshop). Unpublished. Available from OEP/ANL.

TVA is currently evaluating the possible implications of PSD in EPA regulations and in the proposed Clean Air Act Amendments on its power program. Preliminary results of the PSD impact on facility siting and size are estimated using standard EPA models. Major assumptions in the preliminary modeling study are described in the report. Other subjects discussed are (1) alternative energy technologies, (2) measurement of concentration, (3) allocation of increments, (4) PSD effects on TVA power system, and (5) R&D needs.

U.S. Congress, Public Law 95-95, An Act to Amend the Clean Air Act. August 7, 1977, 95th Congress.

----- Technical and Conforming Amendments to the Clean Air Act. Nov. 1, 1977.

U.S. Congress, House, Research and Development Relating to Sulfates in the Atmosphere, June, 1975. (Prepared for the House Committee on Science and Technology, 94th Congress, 1st Session).

----- Effects of Chronic Exposure to Low-Level Pollutants in the Environment, November, 1975. (Prepared for the House Committee on Science and Technology, 94th Congress, 1st Session).

----- Clean Air Act Amendments of 1976, May 15, 1976. Committee on Interstate and Foreign Commerce. Report to accompany H.R. 10498 together with additional, separate, opposing and minority views. (94th Congress, 2nd. Session, Report No. 94-1175).

----- Clean Air Act Amendments of 1976. Supplemental Report to accompany H.R. 10498 together with additional views, May 25, 1976. Committee on Interstate and Foreign Commerce. (94th Congress, 2nd. Session, Report No. 94-1175, Part 2).

----- Clean Air Act Amendments of 1976. Summary of the Bill (H.R. 10498). Committee on Interstate and Foreign Commerce, May, 1976. (94th Congress, 2nd. Session, Committee Print No. 21).

----- Additional Issue for the Week of August 2, 1976, July 30, 1976. Vol. V. #26, Part III. House Republican Conference.

----- Clean Air Act Amendments of 1976. Fact Sheet, August 2, 1976. Democratic Study Group.

----- Clean Air Act Amendments of 1976. Conference Report to accompany S. 3219, September 30, 1976. (94th Congress, 2nd Session, Report No. 94-1742).

----- The Environmental Protection Agency's Research Program with primary emphasis on the Community Health and Environmental Surveillance System (CHESS): An Investigative Report, November, 1976. Report prepared for the Sub-Committee on Special Studies, Investigations and Oversight, and the Sub-Committee on the Environment and the Atmosphere, of the Committee on Science and Technology. (94th Congress, 2nd. Session, serial SS).

----- Clean Air Act Amendments of 1977 (H.R. 4151), February 28, 1977. Committee on Interstate and Foreign Commerce. (95th Congress, 1st Session, Report No. 95-564.)

----- Clean Air Act Amendments of 1977, Conference Report, (to accompany H.R. 6161), August 3, 1977. (95th Congress, 1st Session, Report No. 95-564.)

----- Clean Air Act Amendments of 1977. Report by the Committee on Interstate and Foreign Commerce, to accompany H.R. 6161. May 12, 1977. (95th Congress, 1st Session, Report No. 95-294.)

U.S. Congress, Senate, National Air Quality Standards Act of 1970, September 17, 1970. Committee on Public Works. Report together with individual views to accompany S. 4358. (91st Congress, 2nd. Session, Report No. 91-1196.)

----- Potential Effects of Application of Air and Water Quality Standards on Agriculture and Rural Development, January 2, 1975. Committee on Agriculture and Forestry. Subcommittee on Rural Development. Compiled by Joseph P. Biniek. (93rd Congress, 2nd. Session.)

----- Air Quality and Stationary Source Emission Control, March, 1975. Committee on Public Works. Report by the National Academy of Sciences. (94th Congress, 1st Session, Committee Print Serial No. 94-4.)

----- Clean Air Amendments of 1976, March 29, 1976. Committee on Public Works. Report together with minority and individual views to accompany S. 3219. (94th Congress, 2nd. Session, Report No. 94-717.)

----- An Act, to Amend the Clean Air Act, as Amended, August 5, 1976. S. 3219. (94th Congress, 2nd. Session.)

----- A Bill to Amend the Clean Air Act, as Amended, January 14, 1977. S. 252. Committee on Public Works. (95th Congress, 1st Session.)

----- A Bill to Amend the Clean Air Act, as Amended, January 14, 1977. S. 253. Committee on Public Works. (95th Congress, 1st Session.)

Vierath, D.R. and Warren W. Walkey, An Evaluation of Additional Production Costs from Significant Deterioration and Best Available Control Technology Proposals. April 26, 1976. (Prepared for General Electric.)

This report presents an assessment of the additional capital and operating costs that would be incurred by the electric utility industry as a result of significant deterioration and Best Available Control Technology (BACT) proposals considered by the House and Senate in 1976.

Williams, Michael, Allocation of Assimilative Capacity. 1976. Unpublished. Available from OEP/ANL.

This paper presents a case study of the air quality constraints on energy development in northwestern New Mexico. The pollution control levels that would be required for the existing plants and new plants in planning at Four Corners and San Juan are investigated according to surrounding high terrain, meteorological conditions, emission regulations (NSPS, state regulations), and ambient standards (NAAQS, state standards, and PSD). Other pollution problems such as acid rain and visibility are also discussed.