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PROPOSED?

FINAL ENVIRONMENTAL IMPACT STATEMENT

REVIEW & ESTABLISHMENT OF NATURAL GAS CURTAILMENT PRIORITIES

Volume 3

U.S. Department of Energy

Economic Regulatory Administration

October, 1980

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I. COVER SHEET

Responsible Agency: U.S. Department of Energy
Economic Regulatory Administration
Office of Regulations and Emergency Planning

Title of Proposed Action: Programmatic Review and Establishment of Natural Gas Priority Categories

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Designation: Final Environmental Impact Statement

Abstract: This Final EIS (Volume 3) and accompanying Regulatory Analysis (Volumes 1, 2, and 4) are prepared by the Economic Regulatory Administration (ERA) as part of a comprehensive programmatic review of alternatives to existing federal policy on curtailment of natural gas deliveries during periods of shortage. The curtailment of natural gas causes economic impacts and it causes curtailed users to substitute fuels which increase pollution. The findings of the Regulatory Analysis show that some alternative curtailment policies will reduce economic impacts below the level associated with existing federal policy. The findings of the EIS show that, for any given level of shortage, there are negligible overall differences between environmental impacts of alternative curtailment policies and environmental impacts of existing federal policy. No viable alternative was found which could reduce the overall level of environmental impacts. However, the Federal Energy Regulatory Commission (FERC) can, under any policy alternative, exercise mitigation measures to reduce the level of impact in cases of special hardship.

II. SUMMARY

A. The Problem: Natural Gas Curtailment

Since the late 1960's, shortages of natural gas have caused curtailment of service by interstate pipelines, particularly during winter season periods of peak demand. The long-run outlook is for continuing depletion of natural gas supplies and for capacity constraints during peak demand that will require curtailment by many interstate pipelines. The objective of federal curtailment policy is to minimize the impacts of these shortages.

When a supplier has insufficient gas to satisfy all demand, certain customers are selected to be curtailed. Since residential and other small users cannot be curtailed effectively, the cutbacks are focused on larger users, primarily in the industrial and electric utility sectors. Federal policy attempts to assure that these curtailments are equitable (i.e., treating like users in like fashion) and economically efficient (i.e., putting the gas where it is most needed or most highly valued).

Users who are curtailed may temporarily substitute another fuel for the natural gas they would otherwise use. Some users faced with the likelihood of frequent curtailments elect to permanently convert their facilities to other fuels. Since most of the popular alternative fuels produce greater quantities of air pollution than natural gas, curtailment results in side effects on air quality. Another objective of federal policy, therefore, is to mitigate or avoid these environmental impacts.

B. Existing Federal Curtailment Policy

As a result of natural gas curtailments by interstate pipeline companies, the Federal Power Commission (FPC), in 1973, issued Statement of Policy Order No. 467

(later amended by Orders Nos. 467-A and 467-B). These orders established nine categories of gas use arranged in an order of priority that was to be followed in the curtailment of service. These "end use priorities" of the "467-B policy" placed the highest priority on maintaining service to residential and small commercial users. Lowest priority was given to utility and large industrial users who were already being served on an "interruptible" basis. The other end use categories were defined along a gradient of levels of priority between these extremes.

The FPC implemented its 467-B policy by approving, on a case-by-case basis, curtailment plans submitted by the individual interstate pipelines. Under the Department of Energy Organization Act of 1977, these administrative and enforcement responsibilities for curtailment were transferred to the Federal Energy Regulatory Commission (FERC). The authority to review and establish curtailment priorities was given to the Secretary of Energy.

It is important to appreciate the fact that this existing federal program based on end use priorities does not guarantee that curtailment at the end users' level will always take place in this specified way. This is because sales by interstate pipelines are only an intermediate step in the total distribution system. The usual distribution sequence consists of an interstate sale from a pipeline to a distribution company followed by intra-state sales from the distribution company to end use customers. Although many of the over 1,500 distribution companies try to follow the 467-B curtailment priorities, these intra-state transactions are not directly regulated by the federal government.

C. Programmatic Review of Alternative Federal Curtailment Policies

The Secretary of Energy delegated the responsibility for review and establishment of curtailment priorities to the Administrator of the Economic Regulatory Administration (ERA). In carrying out this responsibility, ERA began a programmatic

review (a comprehesive, national-level policy review including a programmatic EIS) of the existing 467-B policy to determine if any modifications were worthwhile or whether any alternative types of curtailment policies offered significant advantages over the present system.

In 1978, the Natural Gas Policy Act (NGPA) mandated two specific modifications in curtailment priorities: Section 401, granting a separate priority for "essential agricultural uses," and Section 402, providing a priority for "essential industrial process and feedstock uses." The Department of Energy (DOE) authority for policy formulation in these matters was delegated to ERA by the Secretary of Energy. A final rule has already been adopted for the agricultural priority because a statutory deadline for this was specified in the NGPA.

D. National Environmental Policy Act (NEPA) Documentation

This Final Environmental Impact Statement (EIS) and the accompanying Regulatory Analysis present findings of the ERA programmatic review of curtailment policy. As a programmatic impact statement, the EIS reviews the environmental impacts of alternative curtailment policies which may be the subject of ensuing rule making procedures. There is a preferred alternative referred to herein as the "improved 467-B" alternative. This alternative entails no changes from the present system except those mandated by the NGPA (agricultural and process and feedstock priorities) and the encouragement of free flow of gas between pipelines. This alternative was the basis for the proposed rule issued on July 2, 1980 (10 CFR Part 580). The final rule incorporates minor changes but is essentially the same.

In line with new NEPA regulations of the Council on Environmental Quality, the Final Environmental Impact Statement can be combined with another DOE document such as the Regulatory Analysis to avoid duplication of material. This is accomplished

as follows. Volumes 1, 2, and 4 develop the Regulatory Analysis in detail. This third volume contains the Final Environmental Impact Statement. Section V of the EIS includes a summary of the Regulatory Analysis to provide a complete background for those primarily interested in the EIS.

E. Alternatives Considered

The Regulatory Analysis evaluates a wide range of altenatives that were chosen to represent different generic approaches that may be taken to minimize inequities and economic inefficiencies in curtailment. The EIS compares the environmental impacts of all of these alternatives to the status quo and identifies measures to mitigate these effects. The EIS also explores other alternatives representing "best environmental" approaches to curtailment in which the minimization of environmental effects is taken as the primary objective. The results of these analyses are summarized in the following two sections.

F. Results of Regulatory Analysis

The Regulatory Analysis evaluates alternatives within the following three generic classes of curtailment strategies:

- Rationing
- Pricing
- Beyond Curtailment

"Rationing" covers the whole class of curtailment schemes that are based on a set of administrative rules. Rationing alternatives are perceived to be the most equitable and, sometimes, an efficient means of allocating available supply. Some policy alternatives are aimed at making rationing plans work better in the presence of real world complexities while others attempt to improve the economic efficiency of rationing plans. Both types of strategies may impose heavier administrative burdens.

The existing rationing system that has developed under present federal curtailment policy is used as a reference case for comparing alternatives. The "do-nothing" alternative projects this status quo into the future with no changes. The changes mandated by the NGPA, requiring priorities for agriculture and process and feedstock uses, are examined as modifications to the status quo.

"Pricing" covers approaches using market forces to allocate gas during shortages. Allocating gas by allowing price increases during shortages is the most economically efficient type of curtailment policy, but it has limitations. The feasibility of pricing alternatives is limited by legal, institutional, and informational barriers.

Going "beyond curtailment" there are alternatives which combine curtailment policy with other policy on natural gas supply and use. The major alternative in this category is the modification of rate structures for gas service to reflect the risk of curtailment. Rate structures affect all aspects of gas supply and demand. There are legal and practical obstacles also limiting the feasibility of this idea.

Supply projections (through 1990) used in the Regulatory Analysis take account of the supply provisions of the Natural Gas Policy Act of 1978 (NGPA). High, low, and base case annual demand and supply projections were used to provide a range of shortages beyond those generated by weather fluctuation. In even the most optimistic cases of increased supply and increased storage, there will be short periods where curtailment is necessary because weather causes sharp peaks in demand.

The Regulatory Analysis presents quantitative comparisons among alternatives and presents summaries of the economic efficiency of the three generic approaches to curtailment. Economic efficiency is judged on two types of costs: user shortage costs (the impacts of shortages on end users) and supplier operating costs (the costs of efforts to minimize or avoid shortages). The table below summarizes order-of-magnitude cost estimates associated with specific alternatives based on the most probable or base case annual demand for the 1981-82 winter season. Detailed findings of the Regulatory Analysis are presented in Volume 1.

	User Shortage[1/] Costs (Billion $)	Supplier[1/] Operating Costs (Billion $)
Rationing Approach		
"Do-nothing" Variant	$ 5.6 B	$ 18.0 B
"Improved 467 B" Variant	4.1 B	18.5 B
"Percentage Limit" Variant	4.5 B	18.0 B
"Agricultural Priority" Variant	6.4 B	18.1 B
"Process and Feedstock Priority" Variant	5.6 B	18.0 B
"Rolling Base" Period	5.7 B	18.1 B
Pricing Approach		
"Auction" Variant	3.3 B	18.5 B
"Auction Within Incremental Pricing" Variant	5.2 B	18.2 B
Beyond Curtailment Approach		
"Rate Structure" Variant	1.4 B	18.6 B

[1/] *The difference between the amount shown for the "Do-nothing Variant" and the other alternatives indicates the impact of each variant; e.g., the impact of the "Improved 467-B Variant" is $1.0 billion*

G. Results of Environmental Impact Analysis

1. Air Quality Analysis

The most direct and obvious environmental effect of natural gas curtailment is that alternate fuels burned during periods of shortage produce an increase in air pollution emissions. Analysis of this effect at a national level is made difficult by the fact that air quality is a very local site-specific phenomenon and there are over 150,000 curtailable end users whose individual locations, alternate fuel capabilities, and curtailment experiences are not precisely known.

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Preliminary examination of the general geographic patterns of gas use and gas curtailment suggested an analytical approach. Approximately 68% of total industrial gas use takes place in major urban areas (Standard Metropolitan Statistical Areas -- SMSA's). Many of the serious air quality problems also occur in urban areas and these areas contain the largest populations exposed to air pollution. Favorable availability of data from major urban areas made it possible to construct 54 case studies of the largest gas-consuming urban Air Quality Control Regions (AQCR's) in the nation. This sample is a large number of case studies, includes most of the major cities in the nation, and accounts for about 61% of total industrial gas use (89% of industrial gas use in SMSA's). The data base developed for these 54 AQCR's was coupled with a computer model designed to calculate the emissions impacts of different approaches to curtailment. This large sample of case studies was examined in detail to evaluate a broad range of types of air quality impacts that might result from alternate curtailment policies. As discussed below, an auxiliary analysis of smaller gas-consuming cities and non-metropolitan areas was also performed.

The environmental model employed in the analysis of these 54 AQCR's is based on the proportional model or rollback model. It assumes simply that ambient pollutant concentrations are proportional to emissions. This model is regarded as an "order-of-magnitude" as opposed to a "precise" predictor of local ambient pollution levels. It is very suitable for programmatic national-level analysis which is necessarily a generalization of local phenomena. This is an especially useful approach when, as in this case, there is an existing policy and the impacts of alternatives are measured relative to the status quo, independent of the absolute quantities involved.

The "do-nothing" alternative represents the continuation of the status quo which has resulted from the existing 467-B policy. The order-of-magnitude results for the "do nothing" alternative, evaluated at the base case level of demand in 1981, show that, in 51 of 54 AQCR's, curtailment contributes less than one microgram per cubic meter to the 24-hour average annual concentration of sulfur dioxide. In 39 of 54 AQCR's, curtailment under the status quo contributes less than one microgram per cubic meter to the 24-hour average annual concentration of particulates.

These results are evidence that the order-of-magnitude impact of curtailment under the status quo is in a low range in most places. This is supported by the fact that these results are based on some very conservative assumptions. In order to err on the side of over-estimating the impact, it was assumed that all curtailed gas users have alternate fuel capability and that their choice of alternate fuels is biased toward those which produce the most pollution. In addition, a relatively extreme level of winter season shortage was assumed, having only a 1-in-10 probability of occurring.

Using the same conservative assumptions, the results for all other curtailment policy alternatives (i.e. all candidate changes from the status quo) were found to lie in the same order of magnitude as the "do-nothing" alternative. In every case, the contribution of alternate curtailment schemes to annual average pollutant concentrations is in the same range of one microgram per cubic meter or less for most of the 54 AQCR's. The net effect, therefore, of any of the alternative changes from the existing status quo is essentially zero.

These similar results for all alternatives are explained by the fact that the large quantities of emissions from other sources in these major industrial areas completely overshadow the emissions from alternate fuels burned during winter season natural gas curtailments. Compared to the "do-nothing" alternative, the other curtailment alternatives have the primary effect of shifting some limited portion of the curtailment - - and, therefore, of the alternate fuel use - - from one category of gas users to another. In general, the amount of gas involved in these shifts and the difference in emission coefficients between categories is not enough to make the results significantly different from the do-nothing alternative.

In almost all cases, the AQCR's displaying the higher absolute impacts are found to be located in the gas-producing states or in states that are heavily dependent upon gas such as California and Kansas. In part this result is due to the fact that any switch away from clean-burning gas is more noticeable in these areas where it is the dominant fuel. These results are also due partially, however, to some possibly overconservative

assumptions about curtailments in the intra-state pipeline systems. Intra-state pipelines serving the producing states are not subject to federal curtailment policies, but are included in the EIS so as not to restrict the search for a "best environmental" policy.

There are two types of special cases which may produce local impacts outside the order of magnitude indicated by these results. At a local sub-AQCR level, there may be unusually dense concentrations of industrial land use which include a large proportion of interruptible gas users. Such clusters may have the potential to produce larger pollution increments on a recurring basis in a local area. An environmental exemption procedure such as that envisioned for administration by the Federal Energy Regulatory Commission (FERC) under Section 502 of the NGPA can be used as a mitigating measure to try to avoid these circumstances. These special cases can only be identified and documented on a case-by-case basis using site-specific data and analytical techniques. The FERC staff is suitably equipped to perform this task.

Another type of special case may result from the occurrence of local short-term conditions of extremely poor dispersion at a time of extremely high curtailments. Winter inversions, for example, are known to occur in many of the areas under study. This type of extreme emergency could be mitigated through the provision of relief by either DOE (providing more gas through special procedures for emergency or extra-ordinary relief) or EPA (restricting alternate fuel use through emergency powers).

As mentioned earlier, an analysis of smaller gas-consuming cities and non-metropolitan areas was also performed. Constrained by data available at this level, this analysis shows nonetheless that some of these cases may also be candidates for the Section 502 exemption procedure. The candidate cases would be those where gas is the predominant fuel, the emissions from other sources are not of great magnitude, and the same conservative assumption of 100% alternate fuel capability holds. In these circumstances, the absolute impact of curtailment, under any federal policy alternative, can be proportionately greater than in larger industrial cities.

The extent to which these circumstances would require special case treatment is heavily dependent upon the assumption of 100% alternate fuel capability in areas that may be more remote from major fuel supply markets and distribution centers. The other important variable, the proportion of fuel use made up of natural gas, can be estimated from data available for 88 smaller gas-consuming SMSA's (representing 7% of total industrial gas use). About half of these cities were found to be more than 50% dependent upon gas. These more gas dependent small cities follow the same geographic pattern as observed in the more gas dependent of the 54 AQCR's, exhibiting a concentration in California and the gas-producing states. A number of these cities are served by intra-state pipelines and are not very heavily curtailed. Among those served by interstate pipelines, however, it is conceivable that there are some cases where the particular mix of customers is very unbalanced between different curtailment priority categories. Some of these cities could be more vulnerable to changes in curtailment policy, therefore, while others could be more insulated from changes. The exemption procedure mentioned above can be used to alleviate any severe imbalances which may exist.

The results of the analysis of small gas-consuming cities can be extended to the case of non-metropolitan areas. In this case, plant-by-plant data would be necessary to examine all of the possible circumstances that could arise. Some of these may be worth considering as special cases and candidates for an exemption procedure.

An interesting finding of the EIS is that, in the case of a pricing or rate structure alternative, special cases may not require as much use of federally administered mitigation measures. This could come about because many state air pollution control authorities have the ability to influence users' willingness-to-pay for natural gas. If the pollution free properties of the fuel were appropriately valued in these special cases, then they may not develop into problem areas. Some of this type of automatic mitigation could probably occur under the pricing and rate structure alternatives.

A "best environmental" alternative curtailment policy was sought by adding a number of constraints to the environmental model used to calculate emissions impacts for the 54 large gas-consuming AQCR's. Under these constraints the model curtails gas according to priority categories subject to the restrictions: (1) that there are no curtailments in areas exceeding the EPA Secondary Ambient Air Quality Standards and (2) that the size of the increment added to ambient pollutant concentration is equal in all areas curtailed. These constraints are similar to the EPA non-attainment and urban prevention-of-significant-deterioration policies.

The outcome of these analyses is, as might be expected, that the larger absolute impacts shown in a few AQCR's can be avoided. As noted earlier, however, these larger absolute impacts are somewhat suspect, few in number, and could possibly be treated as special cases. The gains of the best environmental alternative are not otherwise very significant. Problems of implementing such an alternative could by contrast be very great. The administrative task of determining the optimal allocation of gas on a continuing basis would be an enormous undertaking. The degree of government intervention required might induce permanent switching away from gas to alternate fuels. Above all, such reallocation may prove to be a sub-optimal* environmental solution due to the long range transport of pollutants from one location to another.

A variation on the above winter season approach to a best environmental alternative was also considered. This entailed day-to-day allocation of gas along individual pipelines according to an index of wind dispersion characteristics in major cities along each pipe. Outwardly, this approach appears administratively simpler and more precise. Serious deficiencies in this approach, however, include a greater potential for permanent switching to alternate fuels and a greatly increased risk of sub-optimal* results due to pipeline interconnections and long range transport.

"Sub-optimal" describes a solution which appears to be optimal only because some larger aspect of the problem has not been taken into account.

It was concluded that the best environmental alternative does not gain much at the programmatic level, entails significant administrative obstacles and economic impacts, and may not in fact be environmentally optimal if long range transport is taken into account. Below the programmatic level, the best environmental alternative is to provide an exemption procedure that can be applied to those exceptional cases where curtailment might cause extreme air quality impacts.

2. Other Environmental, Health, and Safety Issues

Other environmental, health and safety issues associated with natural gas curtailment are also addressed in this Final Environmental Impact Statement including: water pollutants; solid wastes; resource extraction, transport, and storage; and occupational safety and health. Section V of the EIS quantifies the levels of such pollutants as total suspended solids, total dissolved solids, BOD, nitrogen, phosphorous, and organic compounds that are typically produced by alternate fuel combustion to replace curtailed natural gas. The actual chain of causation that finally determines the importance of impacts in these categories is more attenuated and further removed from curtailment policy than is the case with air quality impacts. In all of these categories of impact, the total quantities do not differ greatly from one curtailment policy to another, but the geographic patterns of impact may change somewhat.

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IV. PURPOSE AND NEED FOR ACTION

Under the Department of Energy Organization Act of 1977, the Department of Energy (DOE) was given the responsibility and authority to establish and review curtailment priorities which was formerly exercised by the Federal Power Commission. The Natural Gas Policy Act of 1978 (NGPA) mandated two curtailment modifications: Section 401, granting a specific priority for "essential agricultural uses," and Section 402, proposing a priority for "essential industrial process and feedstock uses." The Secretary of Energy's authority for these matters was subsequently delegated to the Administrator of the Economic Regulatory Administration (ERA). In carrying out these responsibilities, ERA is conducting a comprehensive review of alternative improvements in gas curtailment priorities. Documents pertaining to this review include this Programmatic Final Environmental Impact Statement (Volume 3) and the accompanying Regulatory Analysis (Volumes 1, 2, and 4).

As a programmatic impact statement, the EIS reviews the environmental impacts of the alternative types of curtailment policies which may be the subject of ensuing rule-making procedures. A final rule has already been adopted for the agricultural priority because a statutory deadline for this was specified in the NGPA. There is a preferred alternative referred to herein as the "improved-467B" alternative. This alternative entails no major changes from the present system except those mandated by the NGPA (agriculture and process and feedstock priorities) and the encouragement of free flow of gas between pipelines. This alternative was the basis for the proposed rule issued on July 2, 1980 (10 CFR Part 580). The final rule incorporates minor changes but is essentially the same.

The objectives of this programmatic review were to examine ways in which federal curtailment policy can be used to:

- improve the equity and economic efficiency of curtailment, and
- lessen the environmental impacts associated with curtailment.

These objectives were approached through the evaluation of a number of broad classes of alternative curtailment strategies. The focus of analysis for all evaluation criteria is on the net difference between a given alternative and no change from the present curtailment priority system (the "do-nothing" alternative). Despite the modifications mandated by the NGPA, the effects of the present system are the only experience documented in historical data. Hence, "the do-nothing" alternative, representing no change from the present system, is projected into the future as the status quo or reference case against which other alternatives are measured.

V. ALTERNATIVES INCLUDING THE PREFERRED ACTION

This section presents comparative analyses of the impacts of alternative federal actions. In keeping with CEQ guidance the analysis in this section is focused on what have been identified as the major issues. The presentation is made in four parts as follows:

Part 1 - Description of Alternatives

Part 2 - Economic/Regulatory Analysis

Part 3 - Air Quality Analysis

Part 4 - Other Environmental, Health And Safety Issues

Part 1 presents the major classes of alternative approaches to curtailment and describes the individual examples of these categories that were selected for analysis. It is emphasized that curtailment is an existing phenomenon and there is an existing federal policy to deal with it. The "do-nothing" alternative is defined as the continuation of the existing end use rationing system with no changes in Federal curtailment policy. There are economic and environmental impacts associated with that status quo. The analyses presented in parts 2, 3 and 4 develop impact estimates for the alternative approaches to curtailment providing a basis for evaluating the differences in impact between the alternative actions and the status quo.

Both Part 1 and Part 2 are abstracted from the Executive Summary of the overall study contained in Volume 1. Volumes 1, 2, and 4 contain the completed details of the material summarized. In keeping with CEQ guidance the detailed material is not duplicated here in the EIS because all four volumes are being circulated together.

The most direct and obvious environmental effect of natural gas curtailment is increased air pollution emissions due to the use of alternate fuels during periods of shortage. Part 3 presents the results of the environmental analysis in the tasks of: (1) assessing the air quality impacts of the selected alternatives, and (2) searching for potentially better alternatives from the standpoint of air quality criteria. Part 4 presents analyses of other environmental issues associated with curtailment policy such as water pollutants, solid waste, occupational safety, and resource extraction and transportation.

Part 1. Description of Alternatives

There are variations among the curtailment priority plans presently being used, although most are based on the end-use theory; and there are variations among possible alternative types of plans. The range of alternatives is easier to understand by developing the classification and the hierarchy of choices shown in Figure 1. Whereas there are many more specific options than the 15 examples shown in the third column -- third-level of the hierarchy -- there are only three basic approaches to curtailment, as shown at the top of the hierarchy and outlined below.

1. Rationing -- allocation, distribution, or management of available gas supplies by administrative rules applicable during shortages; the present system is an example.

2. Pricing -- allocation of available gas by prices; this is the most precise approach to allocating available gas supplies to users with the highest cost of curtailment.

3. Beyond Curtailment -- allocation that attains goals beyond the goals in managing natural gas curtailments. Overall energy goals can be obtained more easily if management during shortages is combined with management over the long-run. An example of this approach is combining a pricing approach for curtailment with rate structure, as shown in Figure 1 and Table 1.

There is so much variation among specific options within the rationing approach and within the pricing approach that these categories have been subdivided, as shown in the second level of the Figure 1 hierarchy. However, there is a basic theme for each of the three approaches; and it is helpful to review this theme before discussing the subdivision and the specific options that were evaluated and used to illustrate each basic approach.

The rationing approach requires more governmental participation than does the use of pricing. The government must establish (or at least sanction) administrative rules for allocating available gas supplies whenever demand exceeds supply in the short-run capacity shortage and the long-run supply shortage. The current interstate rationing

HIERARCHY IN CLASSIFYING CURTAILMENT ALTERNATIVES

Basic Approach (Alternative Philosophy)	Basic Option (First Level Variation in Approach)	Specific Options Within Each Basic Option (Detailed Variation that is Implementable)
I. Rationing	A. Fixed rationing (base period and allocation rules remain constant to reduce user uncertainty)	1. Do not change the present system 2. Improve present system by freeing gas flow and better storage 3. "Percentage limitation" to avoid extreme impacts in selected categories 4. A binding nationwide rule
	B. Responsive rationing (maximum uncertainty with last moment emergency allocation but allocation can focus on greatest needs, as determined during each shortage)	1. Emergency planning provision 2. "Agriculture priority" uses in NGPA 3. High priority for industrial process and feedstock use 4. Rolling base
II. Pricing	A. Maximum pricing	1. Sales within a pipeline 2. Sales between pipelines
	B. Hybrid (pricing applys only to some uses or price variation is limited, making it necessary to have both rationing and pricing)	1. Limited auction (DOE staff study) 2. Once a year auction, interruptibles only 3. Once a year auction for everyone
III. Beyond Curtailment (other energy policy considered with curtailment)	A. Combine with other policy on gas consumption and production	1. Rate categories and curtailment priority categories are the same
	B. Include policy on other energy forms	

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Table 1: Estimated Order-Of-Magnitude Average Annual Costs Under Varying Approaches
(Average Annual Nationwide Impacts From Pipeline To The Burner Tip By 1981 in Billion $)[c/]

	Row	User Shortage[a/] Impact Cost (1)	User Shortage[a/] Coping Cost (2)	Supplier[a/] Operating Cost (3)	Non-User Pollution (4)	Total Costs 1-4 (5)
I. Rationing Approach						
"Do-Nothing" Variant	1	$4.0 B	$1.6 B	$18.0 B	Reference Case	$23.6 B
"Improved 467-B" Variant	2	3.0 B	1.1 B	18.5 B	Neg. Change[b/]	22.6 B
"Percentage Limit" Variant	3	3.5 B	1.0 B	18.0 B	Neg. Change	22.5 B
"Ag. Priority" Variant	4	4.3 B	2.1 B	18.1 B	Neg. Change	24.5 B
"Process Priority" Variant	5	4.0 B	1.6 B	18.0 B	Neg. Change	23.6 B
"Rolling-Base" Period	6	4.0 B	1.7 B	18.1 B	Neg. Change	23.8 B
II. Pricing Approach						
"Auction" Variant	7	2.0 B	1.3 B	18.5 B	Uncertain Gain[d/]	21.8 B
"Auction Within Incremental Pricing" Variant	8	3.7 B	1.5 B	18.2 B	Uncertain Gain	23.4 B
III. Beyond Curtailment Approach						
"Rate Structure" Variant	9	.6 B	.8 B	18.6 B	Uncertain Gain	20.0 B

a/ Impact cost is production loss and additional cost of alternate fuel; coping cost is amortized investment outlay for additional substitution capability; and operating costs are the sum of costs for the types of supply shown in Chapter 2 (i.e., conventional pipeline supply and one or more peaking supplies) for the November-March winter season.

b/ Negligible change from the "do-nothing" alternative (the reference case)

c/ In constant 1978 dollars; but incorporating the higher rate of increase in natural gas prices than general prices.

d/ Uncertain gain over the "do-nothing" alternative (the reference case)

systems are based on administrative guidelines that establish the priority of deliveries to users every time that curtailment is necessary; low priority uses are curtailed completely before higher priorities each time a shortage occurs, even though the true relative need among priority categories and other factors might change over time.

The pricing approach allows and encourages prices to increase during shortages to bring demand into line with supply. This approach relies on prices offered and paid by gas users to determine the highest valued uses and, thus, the allocation of gas among users during periods of curtailment. Pricing allows users to establish and change their opportunity to get gas (their priority) at each shortage period. Users can increase their reliability of supply via a higher bid if their need increases. A user who stands to be severely hurt by a specific curtailment can bid a high price and obtain gas from users who are in a better position to choose to sell or retain gas. Users would be expected to bid up to the cost of fuel substitution during long-run supply shortages and bid up to the shortage cost during short-run capacity shortages. Study results show that the pricing approach would be an important refinement over rationing in determining the ranking of gas use on the basis of user costs -- i.e., an important refinement if a feasible pricing system can be designed and the costs of changing from the present system are not excessive.

"Beyond curtailment" is a combination of either a rationing or pricing option with policy that is focused on goals beyond managing natural gas curtailments. Energy conservation in general and the NGPA incremental pricing in particular are two policies beyond managing of gas curtailments with which a specific curtailment-management option might be combined. One specific option for the "beyond curtailment" approach was evaluated for this report; namely, an option to combine a pricing scheme which allocates gas during a potential shortage with rate structure which allocates gas over the long-run. The evaluation is given in Table 1 and a description is given in Chapter 3. There are many possibilities for options that go beyond curtailment, but the one evaluated for this report seems to offer the most potential for reducing costs.

After the underlying philosophy for the three basic approaches was delineated, each approach was subdivided and the specific curtailment options were grouped by subcategory. Nine of the specific options were simulated and cost estimates are given in Table 1. Other specific options were evaluated without simulations, as explained later.

The important subdivision within rationing is the set of options where priority classification remains fixed and the set of options where priorities are changed in response to new perception of relative needs. Fixed rationing evolves from a philosophy that whatever error there may be in present rationing should be accepted so that users have confidence that the same plan will be continued; users can adjust to specified allocations even though the allocations may not be as efficient as they could be if the system were being designed anew.

As shown in the Figure 1 classification, four specific options were considered under the fixed rationing basic option:

1. Do-nothing option -- this is a continuation of the present nationwide set of curtailment plans prior to the NGPA legislative mandate for "agriculture priority" and "incremental pricing." This option was simulated and used as a reference for evaluating other alternatives because it is easier to understand than an alternative where the effects of "agriculture priority" and "incremental pricing" must be predicted and included.

2. Improvement in the present system by freer gas flow between interstate systems and improved storage -- this option allows and encourages easier sales between pipeline systems and it encourages the changes in rate structure that will allow better use of storage for reducing shortages. The option was evaluated by assuming that all gas not required for firm customers could be sold off system and assuming that storage would expand to where cost of additional storage is equal to the shortage cost that would be eliminated through increased storage capacity.

3. Percentage limitation option -- this is an expedient way to avoid the largest shortage costs within intermediate priority categories. Survey results indicate that curtailments above 80% often caused a high portion of the total shortage costs through the years. This option was simulated by limiting curtailment of selected priority categories to 80% -- i.e., a higher priority category was curtailed before increasing the curtailment of selected categories from 80 to 100%.

4. A binding nationwide rule option -- this would be a change to a uniform nationwide priority classification for all interstate gas pipelines; in essence it would expand the legislative mandate for a nationwide "agriculture priority" to all uses. Since this would greatly disrupt present curtailment plans and self-help measures, it can be dismissed without precise estimates of cost increases. It can be expected to increase costs more than the order-of-magnitude estimate of $.9 billion per year for the "agriculture priority" which is discussed later.

There are other examples of options under fixed rationing, but the above provide sufficient insights for developing important study findings.

Responsive rationing evolves from the philosophy that priority categories should be changed when new insights on relative importance of needs for natural gas arises. The flexibility aspect is good, but the uncertainty that this creates and the possibility that each change can also generate increased costs which exceed the benefits of the change appears to more than offset the value of flexibility. As shown in Figure 1, there are four specific options that illustrate responsive rationing:

1. Emergency planning provision -- the emergency authority provided by Title III of the NGPA is a good example of responsiveness because it allows allocation in response to the specific conditions in each shortage. This specific allocation scheme was not evaluated because it is based on legislation outside the scope of establishing curtailment priorities, but the basic idea is a good example of responsive rationing.

2. "Agriculture priority" -- The essential agricultural-use priority established by the NGPA illustrates responsive rationing because it reflects the intent of Congress to respond to special agricultural needs. Costs of curtailments to those below the agricultural priority are increased, and users become more apprehensive about further changes which may abort their efforts to plan around existing curtailment patterns.

3. "Process and feedstock priority" -- this change, also mandated by NGPA, is another example of responsive rationing. Higher priority will be established in response to perceived needs for essential industrial process and feedstock uses.

4. Rolling base -- The rolling base period approach reviewed in this report is an annual update in the index of requirements from which curtailment is measured and is based on a two year moving average of gas consumption. A rolling base period can incorporate legitimate priority changes in the pattern of end-use over time, but it is more likely to negate self-help measures.

The second and fourth examples are discussed further in the evaluation of cost estimates presented in Table 1.

The best subdivision of pricing is between the option where use of pricing is maximized and the set of options where pricing is restricted. With any restriction on pricing it is necessary to develop a hybrid of the pricing and rationing approaches. An option where pricing is used exclusively for allocation during shortages was considered, but was not evaluated in detail because it is less practical than a pricing scheme combined with rate structure -- i.e., a pricing approach which is "beyond curtailment" because rate structure determines allocation of natural gas during periods when no supply shortages exist. As shown in Figure 1, complete reliance on pricing would involve bidding between pipeline systems and bidding among all users within a pipeline system. This extensive bidding would be very cumbersome, unless it is integrated with rate structure, as in the last row of Figure 1 and Table 1.

A hybrid pricing system can have many types of limits on price variation or participation. The three limits on pricing that are shown in Figure 1 and outlined below were considered.

1. Bidding among users in the first stage of NGPA incremental pricing -- this bidding is limited to gas consumption for large boiler-fuel use, as directed in the NGPA. The order-of-magnitude estimate of $.2 billion per year cost saving shown in Row 8 of Table 2 could be larger if incremental pricing is extended to more users.

2. Once-a-year auction for interruptible users only -- this option resembles a plan designed by the Public Service Commission of Wisconsin (see Appendix 2D in Volume 4) in which price changes only once a year and bidding is only among interruptible users. This option was not simulated because the cost reduction would be very small, given both restrictions.

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3. Once-a-year auction for all users who are given a base allocation -- this option would establish the base allocation for users during a bidding conducted once per year. Since it does not allow responsiveness to weather-related short-run shortages, it does not reduce costs as much as the option which combines bidding and rate structure in the "beyond curtailment" approach (see Rows 7 and 9 in Tables 1 and 2).

There are other hybrid systems, but those shown in Figure 1 and evaluated in Table 1 reveal the magnitude of the cost reduction that can be obtained.

The best subdivision for the "beyond curtailment" approach is the set of all options which focus on natural gas and the set of options which focus on other energy forms. Only the former was considered in this study and only the most prominent among specific options could be evaluated with available data.

The most prominent and obvious option for including goals "beyond curtaiment" is one which combines curtailment and rate structure. It is the obvious combination because rate structure affects all aspects of gas supply and consumption. This option was found to be the best possible means for reducing total costs related to natural gas supply and curtailment; therefore, it becomes the reference for determining how far any specific option falls short of what is theoretically attainable in managing natural gas curtailments.

In this option, the priority categories would be the same as rate categories and users could chose their curtailment category by the price they are willing to pay by priority category. The rate structure would vary depending upon demand and total supply. In addition, there would also be a spot market to allow resale of gas and, thus, a shift to higher value users during short-run shortages. A complete description of the price responsiveness that this option provides is given in Appendix 5D of Volume 4.

This option would also encourage suppliers to provide optimum storage and other peaking capacity. The spot market prices would indicate the true value of gas to users, and suppliers would increase peaking up to the point where amoritized cost per unit supplied equals the spot market price.

Both Federal and State regulatory practices, and possibly Federal laws, preclude implementation of this option. In particular, a satisfactory means for handling the excess profits as prices increase have not been developed. The option is included to determine the theoretical limit to which costs can be reduced.

Further description of alternatives is in Chapter 3 of Volume 1 and Chapter 1 of Volume 4.

Part 2. Economic/Regulatory Analysis

Alternatives are first reviewed in terms of macro-economic impacts and reductions in total costs. Then, alternatives with greatest reductions in costs are reviewed in terms of equity, practicality, and contribution to other special goals.

The selection of a curtailment option has no significant affects on real GNP. Curtailment impacts on gas users are offsetting because any permanently lost production of goods and services by a curtailed end-user is made up by other establishments and temporarily lost production is made up later by the same end-user. However, the reduction in costs of curtailment under improved curtailment plans would avoid inflationary effects -- the inflationary effects of cost increases stemming from delayed production and from shifting production among producers because of curtailment. Our analysis shows that the net macro-economic effect of any option that reduced curtailment costs is a reduction in the amount of inflation equal to the reduction in total costs, as shown in Tables 1 and 2.

The economic consequences of each curtailment alternative were derived through simulations of supplier operations, user fuel substitution, and user shortage impacts from curtailment. Estimated costs in our analysis represent the average cost of curtailment for 100 possible weather patterns for a specific winter season varying from much warmer to much colder than normal. Our analysis shows that estimated average annual costs are higher than the estimated costs for a normal winter (i.e., normal winter season) due, in large part, to the influence of the extremely high costs of curtailment during much colder than normal winters. The high costs result from curtailment of gas deliveries to consumers who cannot readily convert to another fuel, causing reduced production of goods and services, plant shutdowns and unemployment. Our study used average annual costs of curtailments rather than costs for a normal

winter, to illustrate the importance of properly managing gas curtailments, especially the severe curtailments that occur during periods of much colder than normal weather. Businesses also incur added costs, such as purchase of additional fuels and alternate fuel capability, to help protect against the unusual curtailment, but major curtailment effects still occur.

The order-of-magnitude estimates of average annual costs shown in Tables 1 and 2 are useful in comparing alternatives for managing curtailment. They provide an easy comparison and ranking of the economic consequences from implementing each alternative. Evaluation of each alternative included comparison with the do-nothing alternative in Row 1 of Table 1 and comparison with the potential savings offered by a pricing option in Row 9 of Table 1.

Table 2 summarizes differences using the do-nothing alternative as a standard. For example, order-of-magnitude estimates show that the pricing option in Row 9 of Table 2 has an average annual cost reduction of $3.6 billion compared to the do-nothing alternative -- a 15.3% reduction in average annual costs. The difference is composed of shortage impact costs, fuel substitution investment, and supplier operating costs as shown in Columns 1-3 in Table 1.

Estimates in Table 1 incorporate all user and supplier costs that are related to curtailment, as explained below. Column 1 -- the short-run impact of shortages on users -- is all costs attributed to a specific shortage; it includes the costs of alternate fuel use, costs of plant shutdowns, and costs of overtime to make up production. Column 2 -- the long-run coping costs of users includes all long-run user costs that help reduce the effect of a shortage when it occurs; an example of coping cost is investments in facilities for alternate fuel capability. Column 3 is supplier operating cost and is included because some alternatives will result in the addition of storage or other peaking facilities which increase supplier costs. Non-user pollution costs in Column 4 are the damages from extra pollution caused by the use of substitute fuels.

The differences in total costs for the nine alternatives shown in Table 2 are important for evaluating options. For example, improvements in the present curtailment priorities system -- Row 2 -- would reduce 1981 average annual costs by $1 billion from the present system if the added costs of implementing the improvements to the system were minimal. Shortage-impact costs on users are reduced by $1 billion, and increased supplier operating costs are offset by reduced user coping costs.

Table 2

Estimated Cost Savings

(Using The "Do-Nothing" Variant As A Reference Case)

	Row	Estimated Cost Savings[a] (1)	Percent Saving In Costs[a] (2)	Comments (3)
I. Rationing Approach				
"Do-Nothing" Variant	1	Reference Case		The present system
"Improved 467-B" Variant	2	1.0 B	4.2	Facilitate free flow of gas between systems
"Percentage Limit" Variant	3	1.1 B	4.7	Avoid impacts from 100% curtailment
"Ag. Priority" Variant	4	- .9 B	-3.8	Required by law
"Process Priority" Variant	5	0.0 B	0.0	Required by law
"Rolling-Base" Period	6	-0.2 B	-.8	Update of index from which to measure curtailment
II. Pricing Approach				
"Auction" Variant	7	1.8 B	7.6	See Chapter 2
"Auction Within Incremental Pricing" Variant	8	.2 B	.8	Only users under Stage 1 of incremental pricing participate
III. Beyond Curtailment Approach				
"Rate Structure" Variant	9	3.6 B	15.3	Should be coordinated with DOE rate design studies required by Section 601 of PURPA

[a] Estimated savings is the difference in total costs shown in Column 5 of Table 1 and percent saving is based on the $23.6 billion total cost under the present system of curtailment.

The "percentage limit" in Line 3 of Tables 1 and 2 is an approach that encourages less than 100% curtailment of certain industrial priority classes in order to reduce impacts caused by reduced production. Our survey of gas users indicates that a small percentage of gas (e.g., 20%) is especially valuable to the end-user, in all but the priority classes for large boiler-fuel use. It reflects the fact that some percentage of an end-users' gas is generally classified in too low a priority when his total gas requirements are placed in only one priority.

A pricing approach could save between about $1.8 billion and $3.6 billion over the present system under the 1981 demand and supply levels, if the added costs of implementing such a system were minimal as shown in Lines 1, 7, and 9 in Table 2. These are based on the assumption that the pricing system could be implemented down to the end-user level (including good information for buyers, sellers, and transportation) so that users with higher shortage costs would get gas ahead of those with lower shortage costs. Pricing approaches establish a theoretical goal for management of curtailments, but pricing must be applied at the end-user level to be effective. Since it does not appear practical to have the end-use customers of distribution companies bidding for interstate pipeline gas supplies, distribution companies must be involved. A good pricing system also requires end-use customers bidding against other customers within a distribution company. This reaches into the jurisdiction of state regulatory agencies. Such a system deserves careful consideration, but it is outside the scope of research for this report which is to analyze various types of curtailment priority systems at the interstate pipeline level.

The $.2 billion annual saving shown for the limited auction in Row 8 of Table 2 could be larger if incremental pricing is applied beyond Stage 1 (boiler-fuel) use of the NGPA specification. The scope of incremental pricing beyond Stage 1 was not sufficiently defined to develop a cost estimate for this report.

The "agriculture priority" and rolling-base[a/] options are discussed in the study findings. Both of these changes increase costs because they reduce the effectiveness of existing self-help measures and will probably add costs for more self-help to meet changes in allocations.

[a/] This option pertains only to systems which presently have a fixed base.

Beyond the cost differences shown in Tables 1 and 2, the most significant difference among options is practicality. Freeing up gas to move between systems is the most practical improvement that can be made in the present system at this time. In the long-run, pricing is the most precise and practical allocation mechanism, but supporting legislation and an acceptable pricing method for suppliers, users, and state regulation of rates is necessary. There must be impetus for necessary changes at the State and Federal levels before a pricing system can be implemented effectively.

Part 3. Air Quality Analysis

A. Framework for Analysis

The National Environmental Policy Act requires that impact statements address the "probable impact" of the proposed action and its alternatives. A broader interpretation of this concept recognizes that the level of impact has an associated probability distribution and that a complete analysis should cover the less probable as well as the most probable outcomes. This latter interpretation results in the development of "worst case" analyses in impact statements.

The worst case analysis can serve two special functions in a programmatic EIS where the estimated level of impact is subject to some unique sources of error and uncertainty. First, environmental analysis at a programmatic level is necessarily a generalization of very site-specific phenomena. Worst case tests can be applied to check the sensitivity of impact estimates to site-specific variations in both the data and the models being employed. Secondly, both data and models (postulated functional relationships) are subject to change over time. The effect of this variation can be picked up in the analysis of alternate scenarios among which there is often a best and a worst.

The concept of a best case is also important. CEQ urges that the search for the best environmental alternative be carried past the limits of agency authority in order that the best conceivable environmental policy does not escape consideration. The best case

thus goes beyond determining the best set of outcomes from among the given alternatives. It must include consideration of alternative types of actions or associated actions (mitigating measures) that have the effect of reducing the possibility of higher levels of impact. Such alternatives frequently amount to redefining the problem by imposing or relaxing a constraint.

Sections B, C, and D which follow hereunder present probable impact, worst case, and best case analyses of the air quality aspects of natural gas curtailment. The probable impact case actually contains some rather conservative assumptions that cause the results to be somewhat of an overstatement of the air quality impact that might realistically be expected. Specifically, it is assumed that all curtailed gas customers have alternate fuel capability and that they have a preference for relatively dirty alternate fuels. This produces a high estimate of the probable impact. The "worst case" analysis is then used to evaluate more extraordinary types of circumstances which may occur in local areas that represent exceptions to the probable case results.

B. Probable Impact

1. Identification of Probable Sites

Because air quality is a very local phenomenon, it is necessary in assessing the probable impacts of natural gas curtailment to determine the areas where gas curtailments are likely to take place. The primary air quality concern is with industrial users of natural gas who substitute dirtier alternate fuels when their gas is curtailed. Industrial development is concentrated in certain regions of the country and this permits a more focused evaluation of the emissions impacts in the areas most likely to be affected. Figure 2 presents a summary of the geographic dimensions of the natural gas curtailment problem.

Generalizing from Figure 2, roughly 80% of industrial gas use [1] and over 80% of industrial gas curtailment takes place in six regions of the country: California, the producing states, the Great Plains, the Industrial Midwest, the Northeast, and the South [2]. Further, these areas have accounted for more than 80% of total use of alternate fuels both as temporary substitutes during curtailment [2] and as permanent switches away from gas [3]. This partitioning of the problem is not at all surprising as the Northwest, Rocky Mountain, and New England areas are not as heavily served by the interstate pipeline system. This is not to say that there are not curtailments in these areas which can generate emissions impacts, but simply that the bulk of the problem is contained in the more heavily industrialized and gas dependent regions.

FIGURE 2. AREAS MOST AFFECTED BY CURTAILMENT

Going one step further, it is also known that most concentrated industrial development and industrial energy use is in major cities. Table 3 taken from the 1976 U.S. Census of Manufacturers [1] illustrates some proportions of urban industrial energy use.

20 largest energy-using SMSA's	4,253.2	
21-60th largest energy-using SMSA's	2,059.1	
Other SMSA's (61-272)	2,340.6	
Total all SMSA's		8,652.9
Non-SMSA Areas		3,972.4
Total U.S. Consumption		12,625.3

TABLE 3. 1976 URBAN INDUSTRIAL ENERGY USE (10^{12}Btu)

The same U.S. Census data shows that industrial gas use is even more concentrated in major cities than is total energy use. Many of the more serious air quality problems are also concentrated in major cities, and they contain the largest populations that are subject to pollution exposure. For these reasons, the study approach selected here is to focus on the major cities likely to be affected by natural gas curtailment. Smaller gas-consuming cities and non-metropolitan areas are also studied later in this section, however. Gas consumption data in the 1976 Census of Manufacturers [1] was used to identify the largest gas consuming standard Metropolitan Statistical Areas (SMSA's).

A group of one hundred SMSA's representing 89% of total industrial gas consumption in SMSA's was selected. These contain many co-terminous SMSA's in large urban regions. In fact, these 100 SMSA's are contained in 54 of EPA's designated Air Quality Control Regions (AQCR's). Because they contain the large urban regions in the country, these 54 AQCR's appear to be the most probable sites of air quality impact from natural gas curtailment. Table 4 identifies these 54 major AQCR's which will be the primary subject of the analysis here.

The map presented in Figure 3 shows that these 54 AQCR's follow the same regional pattern as in Figure 2 except that areas in the Rocky Mountain and Northwest regions are also included. It is noted that these 54 AQCR's include some which are located in areas served by intra-state pipeline systems which are not subject to Federal regulation of curtailment and have not generally had as large a curtailment problem. Nonetheless they are included in the analysis in order that the search for "best environmental" curtailment policies is unrestricted.

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TABLE 4. 54 AIR QUALITY CONTROL REGIONS SELECTED FOR STUDY

(AQCR numbers in parentheses)

Appleton - Oshkosh, Wisconsin (237)
Atlanta, Georgia (056)
Augusta, Georgia - South Carolina (053)
Baltimore, Maryland (115)
Baton Rouge, Louisiana (106)
Birmingham, Alabama (004)
Buffalo, New York (162)
Cedar Rapids, Iowa (088)
Charleston, West Virginia (234)
Chattanooga, Tennessee - Georgia (055)
Chicago, Illinois (067)
Cincinnati, Ohio - Kentucky - Indiana (079)
Cleveland, Ohio (174)
Columbus, Ohio (176)
Corpus Christi, Texas (214)
Dallas - Fort Worth, Texas (215)
Davenport - Rock Island - Moline, Iowa - Illinois (069)
Dayton, Ohio (173)
Denver - Boulder, Colorado (036)
Detroit, Michigan (123)
El Paso, Texas (153)
Florence, Alabama (007)
Grand Rapids, Michigan (122)
Houston, Texas (216)
Huntington - Ashland, West Virginia - Ohio - Kentucky (103)
Indianapolis, Indiana (080)
Kalamazoo - Portage, Michigan (125)
Kansas City, Missouri - Kansas (094)
Lima, Ohio (177)
Little Rock - North Little Rock, Arkansas (016)
Los Angeles - Long Beach, California (024)
Louisville, Kentucky - Indiana (078)
Memphis, Tennessee - Arkansas - Mississippi (018)
Milwaukee, Wisconsin (239)
Minneapolis - St. Paul, Minnesota - Wisconsin (131)
Mobile, Alabama/Pensacola, Florida (005)
Monroe, Louisiana (019)
Nashville - Davidson, Tennessee (208)
New York, New York, New Jersey (043)
Odessa, Texas (218)
Philadelphia, Pennsylvania - New Jersey (045)
Pittsburgh, Pennsylvania (197)
Portland, Oregon (193)
Pueblo, Colorado (038)
St. Louis, Missouri - Illinois (070)
Salt Lake City - Ogden, Utah (220)
San Francisco - Oakland, California (030)
Seattle - Everett, Washington (229)
Steubenville - Weirton, Ohio - West Virginia (181)
Stockton, California (031)
Toledo, Ohio - Michigan (124)
Tulsa, Oklahoma (186)
Wichita, Kansas (099)
Youngstown - Warren, Ohio (178)

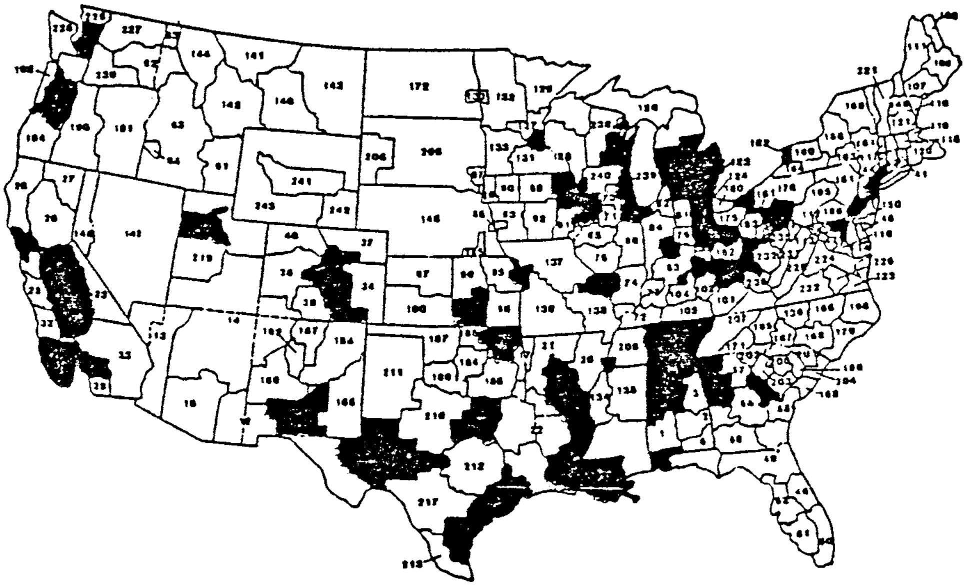

FIGURE 3. AIR QUALITY CONTROL REGIONS SELECTED FOR STUDY

A second group of 88 smaller gas consuming SMSA's (1 to 10 Bcf/yr) was also identified from the Census data mentioned above. These 88 were selected in order to account for an additional 10% of total industrial gas consumption in SMSA's. Potential impacts in the 88 smaller gas-using SMSA's as well as in rural areas will also be addressed as special cases in this analysis.

2. Estimation of Ambient Impacts

a. Ambient Model

Table 5 presents an example of particulate and sulfur oxide emission coefficients for natural gas and its alternative fuels. These two pollutants are the major air quality impacts associated with natural gas curtailment. Results are also presented for nitrogen oxides, hydrocarbons, and carbon monoxide but these are not as significant as particulates and sulfur oxides. As shown in Table 5, the alternate fuel emission coefficients for particulates and sulfur oxides may exceed those of natural gas by several orders of magnitude. The differences in the emission coefficients for nitrogen oxides, hydrocarbons, and carbon monoxide are generally much less severe. The emission coefficients used in the analysis like those in Table 5 are based on the emission limitations specified in present State Implementation Plans (SIP's, required by EPA to demonstrate compliance with Clean Air Act goals) [4].

Sulfur Oxides	Gas	Distillate	Residual	Coal	Propane
Utility	.29	113.	760.	950.	.29
Large Boiler	.29	113.	760.	950.	.29
Small Boiler	.29	113.	760.	1030.	.29
Process	.29	113.	760.	970.	.29
Commercial	.29	113.	558.	1900.	.29
Residential	.29	113.	558.	1900.	.29

Particulates	Gas	Distillate	Residual	Coal	Propane
Utility	5.	54.	67.	95.	5.
Large Boiler	5.	54.	67.	95.	5.
Small Boiler	5.	54.	77.	650.	5.
Process	5.	54.	77.	450.	5.
Commercial	5.	54.	77.	2397.	5.
Residential	5.	54.	77.	2397.	5.

TABLE 5. - EXAMPLE EMISSION COEFFICIENTS (tons/10^{12} Btu)

The coefficients in Table 5 suggest that there is the potential to greatly increase emissions from a given source when alternate fuels are substituted for curtailed natural gas. Table 5 does not say anything, however, about the ambient impact of this increase in emissions. For this question it is necessary to employ some type of pollution dispersion model. This presents some difficulty in a programmatic EIS because levels of ambient air quality are the product of extremely site-specific phenomena, and models of dispersion processes require very site-specific input assumptions to which the results are very sensitive.

In a programmatic study of this scope it is inappropriate to perform detailed site-specific dispersion analysis at every potential site of impact. Site-specific dispersion models take account of such local circumstances as the locations of emission sources, the physical dimensions of smokestacks, and prevailing wind conditions. Use of such techniques in the study of curtailment would require plant-specific data. For example, if a plant has five equal size units connected to three stacks and is curtailed 60%, does this mean that one unit is shut down and two others are switched to distillate? There are obviously a great number of other possibilities. With the new EPA bubble policy, the three stacks to which these five units may be connected (in any number of combinations) may each be equipped for a different level of pollution control.

The simplest of all ambient air quality models, the proportional model, or rollback equation can be used for the type of non-site-specific analysis required for programmatic study. This model consists entirely of the simple assumption that the increase in ambient pollutant concentration will be directly proportional to the increase in emissions.

Actual dispersion patterns seldom behave in such a uniform proportional manner. It is pretty generally recognized that the simple rollback model is not an appropriate tool for making precise estimates of site-specific ambient impacts. The rollback model does have some utility, however, as an indicator of the "potential for" ambient air quality impacts. For while it is by no means clear that emissions are directly proportional to ambient concentrations, it is reasonable to assume that they stand in some proportional relationship to each other. It is in this context that the rollback model is used in this EIS.

The rollback model is perhaps most commonly employed in programmatic or other gross, national-level studies where the results are viewed in this same way, as indicators of the "potential for" ambient impacts. This is a particularly suitable index for the analysis of natural gas curtailment policies as the do-nothing alternative entails emissions in the same order of magnitude as most of the other alternatives. Consequently, relative differences in the ambient impact indicator are more relevant to the comparisons of alternative federal actions than the absolute levels. This is not to say that the absolute levels are not important. They enter into several facets of the analysis. Recognizing this, the worst case analysis in this section presents a sensitivity analysis to estimate some potential errors in the rollback technique. However, it is emphasized that the primary purpose of this EIS is to assess the impacts of alternatives for distributing gas in the event of shortages. The focus of analysis, therefore, is on the net differences of these alternate strategies as opposed to the impact of curtailment per se.

As a last point on the subject, it is noted that there are some intermediate types of ambient models. These consist generally of more simplified dispersion models or more sophisticated rollback models. These are easier to use than the site-specific dispersion

models, but they remain very sensitive to some key input assumptions that replace some of the site-specific detail. This qualification is sometimes not prominently stated. The rollback technique was selected over these approaches because it is clear and simple, containing no hidden assumptions. A very simple and frequently used sophistication for urban applications of the rollback model is to subtract the "background" ambient concentration from the ambient variables. This "background" concentration is the pollution that blows into an area from emission sources upwind. However, estimation of future levels of background concentration for 54 AQCR's involves a great degree of uncertainty and has not been attempted here. Without this variable, the equation has the effect of producing higher estimates of ambient impact which is an acceptable conservative bias.

A mathematical expression of the ambient rollback model is as follows:

$$\frac{\text{New Ambient}}{\text{Existing Ambient}} = \frac{\text{New Emissions}}{\text{Existing Emissions}}$$

OR

$$\text{New Ambient} = (\text{Existing Ambient}) \ \frac{\text{New Emissions}}{\text{Existing Emissions}}$$

The three quantities on the right-hand side of the second equation completely determine the estimate of the potential for ambient impact. Before considering these results, therefore, it is well to describe the data inputs that were utilized for these three quantities. Section VII of this volume provides a detailed description of data sources, methods, and assumptions that were used to develop the data inputs. A brief characterization of the resulting input data is presented here as a preliminary to the discussion of results.

b. Data Inputs and Sample Calculation

The environmental analysis is designed in parallel with the economic/regulatory analysis presented in Part 2 of Section V. Besides a proposed set of alternatives, the major inputs from this other part of the study are the demand and supply projections and the simulated levels of curtailment.

The demand and supply scenarios take the form of a high demand case, a base case, and a low demand case. These different levels of demand are, in the industrial sector, based on varying assumptions about the rate of permanent switching to alternate fuels. These assumptions relate to some provisions of the Power Plant and Industrial Fuel Use Act and the Natural Gas Policy Act [5].

Emission projections for the 54 AQCR's listed earlier were obtained from the output files of a run of the SEAS Model (Strategic Environmental Assessment System) which has similar assumptions to the high demand case [6]. These emission projections for the high demand case were then adjusted, according to the extra amount of permanent switching assumed due to incremental pricing, to produce emission projections for the base case and the low demand case. These projections were used for the "Existing Emissions" variable in the rollback equation for 1981 and 1990 inputs. Table 6 presents an example of the emissions data for one of the 54 AQCR's.

	Sulfur Oxides		Particulates	
	tons/yr.	% of total	tons/yr.	% of total
Utility	1,013,419	88%	85,510	44.3%
Large Boiler	22,109	2%	1,912	1.0%
Small Boiler	48,036	4%	6,173	3.2%
Process	29,150	2.5%	81,600	42.3%
Commercial Residential	28,420	2.5%	5,920	3.0%
Background (includes transportation)	9,707	1%	11,976	6.2%
	1,150,841	100%	193,091	100%

TABLE 6. EXAMPLE EMISSION PROFILE FOR AN AQCR

An estimate of the present annual average 24 hour ambient air quality in each of the 54 AQCR's was derived from EPA's published monitoring data for 1976 [7]. These present ambient levels were combined with the emission projections from SEAS to produce baseline projections of 1981 and 1990 ambient levels using the rollback equation. The resulting estimates are then used as the "Existing Ambient" variable in the equation for the 1981 and 1990 inputs. This procedure unavoidably involves some double counting

because the ambient data used as a starting point already represent the impact of gas curtailment. This error, however is small and does not affect relative comparisons of alternatives.

The "New Emissions" variable is calculated by a computer program designed for this analysis. The equation solved is as follows:

$$\begin{pmatrix}\text{New}\\\text{Emissions}\end{pmatrix} = \begin{pmatrix}\text{Gas}\\\text{Demand}\end{pmatrix} \times \begin{pmatrix}\%\\\text{Curtailment}\end{pmatrix} \times \begin{pmatrix}\text{Fuel}\\\text{Substitution}\\\text{Coefficients}\end{pmatrix} \times \begin{pmatrix}\text{Emission}\\\text{Coefficients}\end{pmatrix}$$

The gas demand and percent curtailment inputs to this equation are inputs from the Regulatory Analysis. As delivered, they required translation from curtailment priority categories into consuming sectors. This adjustment is made by the procedure described in Section VII of this volume. The method used is designed to try to overstate curtailment somewhat to compensate for potential error that could be introduced in this step. Table 7 presents some examples of these data inputs.

The demand and curtailment inputs were developed in the economic/regulatory analysis on the basis of the probability of severe winter weather. Simulation results were produced for climatic events having 1-in-2 (average year), 1-in-10, and 1-in-50 probabilities. To be conservative (i.e., to err on the side of greater environmental impact) the 1-in-10 simulations were used as inputs to most of the environmental analyses.

	Gas Demand		Winter Season Average %
	Bcf/yr.	% of total	Curtailment
Utility	1.67	1%	80%
Large Boiler	3.91	2%	71%
Small Boiler	26.33	16%	64%
Process	27.36	16%	29%
Commercial	29.36	17%	0
Residential	80.22	48%	0
	168.85	100%	

TABLE 7. EXAMPLE DEMAND AND CURTAILMENT INPUTS FOR AN AQCR

Fuel substitution has been the subject of extensive analysis in the preparation of this EIS. These investigations, reported in Section VII of this volume, went beyond the cost considerations examined in the economic analysis to the question of the actual choice of alternate fuel. The resulting assumptions used in the above equation are intended to be conservative, erring on the side of heavy use of dirtier fuels such as coal and residual oil. These assumptions are summarized in Table 8, below.

The emission coefficients used in the above equation are based on current State Implementation Plan regulations. More stringent regulations such as New Source Performance Standards are discussed in Section VII of this volume.

Other important assumptions beyond those identified above are the application of seasonal adjustments to the demands and emissions for evaluation of winter season curtailments. Examples of seasonal adjustment factors are shown in Table 9. The "existing ambient" inputs for particulates are also seasonally adjusted for the winter curtailment analysis by the method described in Section VII of this volume.

Permanent Fuel Switch Coefficients

	Distillate	Residual	Coal	Propane
Large Boilers	0	50%	50%	0
Small Boilers	30%	40%	30%	0

Stand-By Fuel Coefficients

	Distillate	Residual	Coal	Electric & Propane
Utility	20%	40%	40%	0
Large Boiler	30%	30%	40%	0
Small Boiler	45%	45%	5%	5%
Process	20%	0	0	80%
Commercial	45%	5%	0	50%

TABLE 8. SUMMARY OF FUEL SUBSTITUTION ASSUMPTIONS

	Seasonal Demand	Seasonal Emissions
Utility	26%	42%
Large Boiler	31%	42%
Small Boiler	40%	42%
Process	39%	42%
Commercial	54%	60%
Residential	57%	70%
Background (includes transportation)	N.A.	42%

TABLE 9. EXAMPLE SEASONAL ADJUSTMENT FACTORS (% of Annual)

The example inputs given in Tables 5 through 9 may be used to construct a sample calculation to illustrate both the methodology and the results. Table 10 shows such a sample calculation for particulate emissions.

The bottom line in Table 10 indicates a .9% increase in particulate emissions. If the existing ambient level of particulates in this sample case were 80 micrograms per cubic meter (ug/m^3) the potential increase would be about 0.7 ug/m^3, figured by the rollback equation. If this seasonal impact is averaged back into the annual frequency distribution, the effect on the annual average will be smaller.

This sample calculation is an important illustration because it turns out that many of the 54 AQCR's under study have similar input data profiles which produce results in roughly the same order of magnitude. There is a lot of variation between AQCR's and there are some important exceptions to this result. However, the general conclusion in the analysis of probable case impacts is that emission increases due to winter season natural gas curtailments are on the order of one or a few percent with corresponding potential for ambient impact on the order of one or a few micrograms per cubic meter. The actual quantitative results are summarized in the next section.

	Seasonal Gas Demand	x	Demand Curtailment	x	Fuel Substitution Coefficients	x	Emission Coefficients t/10^{12}Btu	=	New Emission Increment
Utility	(1.67 Bcf)(.26)	x	(.80)	x	(.2 Distillate)	x	(54)	=	3.8
	"	x	"	x	(.4 Residual)	x	(67)	=	9.3
	"	x	"	x	(.4 Coal)	x	(95)		13.2
Large Boiler	(3.91 Bcf)(.31)	x	(.71)	x	(.3 Distillate)	x	(54)	=	13.9
	"	x	"	x	(.3 Residual)	x	(67)	=	17.3
	"	x	"	x	(.4 Coal)	x	(95)	=	32.7
Small Boiler	(26.33 Bcf)(.40)	x	(.64)	x	(.45 Distillate)	x	(54)	=	163.8
	"	x	"	x	(.45 Residual)	x	(77)	=	234.0
	"	x	"	x	(.05 Coal)	x	(650)	=	219.0
	"	x	"	x	(.05 Propane)	x	(5)	=	1.7
Process	(27.36 Bcf)(.39)	x	(.29)	x	(.2 Distillate)	x	(54)	=	33.4
	"	x	"	x	(.8 Propane & Electric)	x	(5)	=	12.4
									754.5

	Existing Seasonal Emissions	=	
Utility	(85,510) x (.42)	=	35,914.2
Large Boiler	(1,912) x (.42)	=	803.0
Small Boiler	(6,173) x (.42)	=	2,592.7
Process	(81,600) x (.42)	=	34,272.0
Res. & Comm.	(5,920) x (.65)	=	3.848.0
Background	(11,976) x (.42)	=	5.029.9
			82,459.8

$$\text{increase in seasonal emissions} = \frac{82{,}459.8 + 754.5}{82{,}459.8} = 1.009$$

or

.9%

TABLE 10. SAMPLE CALCULATION

3. Review of Alternate Policy Options

The type of calculation given in the example in Table 10, above, forms the basis of the environmental computer model utilized to evaluate the emissions impacts of the alternate policy options. The environmental model uses this calculation to derive impact transformation curves such as those shown in Figure 4 for each consuming

sector (i.e., large boiler, small boiler, etc.) in each of the 54 AQCR's under study. Noting that the arithmetic operations performed in Table 10 are all linear operations, it follows that the impact transformation curves of Figure 4 are also linear. These relationships may not remain linear over time, however, so different input data sets were developed for 1981 and 1990. Separate evaluation of these cases maintains the linear feature in the analysis.

Using these curves, the environmental model curtails all of the gas available to it in the following order of priority:

1. Utility
2. Large Boiler
3. Small Boiler
4. Process
5. Commercial
6. Residential

The model follows the existing end use curtailment philosophy (the "467-B policy") by curtailing the utility sector in all 54 AQCR's, then the large boiler industrial users, etc., etc. It is noted that the large/small boiler distinction used here is 250 MMBtu per hour because different emission regulations apply above and below this limit. This happens to be larger than the Natural Gas Policy Act (NGPA) distinction which is drawn at 300 Mcf per day.

Several other features have been added to this basic computer model to permit both the analysis of alternate policy options and the search for best environmental alternatives. This is accomplished by imposing constraints on the basic operation of the model. Two such constraints are shown in Figure 4. The horizontal dotted line labled "A" represents an ambient impact constraint or a limit on the ambient impact permitted in a given AQCR. This constraint is used in the search for best environmental alternatives in Section C, below. The vertical dotted line labelled "B" represents a constraint on the amount of gas available for curtailment in a given end use category. Such a constraint may be used to simulate policy options which reassign gas from one priority category to another or affect the depth of curtailment in a given category. A third class of constraints is made available by the fact that there are two different versions of this computer model and associated data sets. One version consists of data sets for twenty five individual pipelines which are constructed to represent the actual delivery system serving the 54 AQCR's. This version takes into account the fact that many large cities are served by several pipelines which may experience different levels of curtailment.

This version of the model is used in evaluating the potential impacts of most policy options. Another version of the model assumes an imaginary pipeline system in which all 54 AQCR's are served on the same pipeline. This version is used for the evaluation of options involving reallocations of gas.

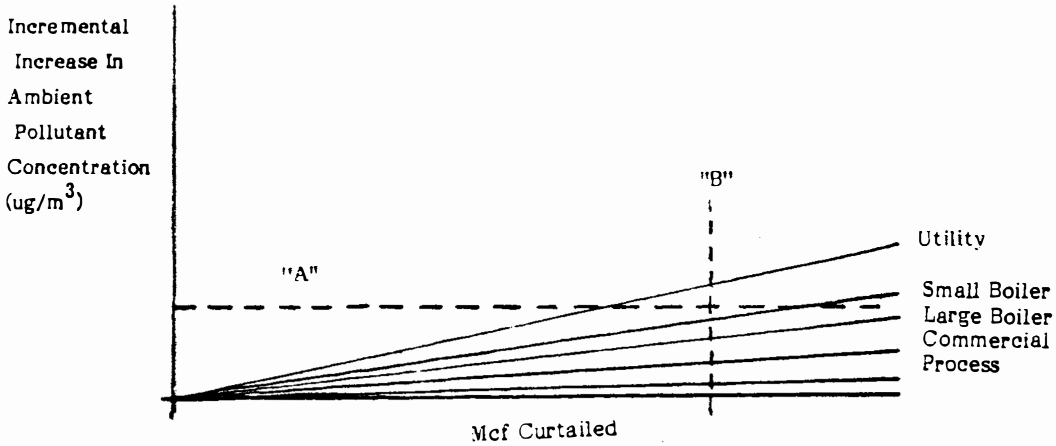

Figure 4. Impact Transformation Curves

a. The "Do-Nothing" Alternative

The environmental model described above is basically patterned after the existing end use priority "467-B policy." Thus, a straightforward run of the actual version of the model, with no special constraints, simulates the ambient impacts of a "no-action" or "do-nothing" policy. It is necessary, however, to use the demand inputs and % curtailed inputs to specify the amount to be curtailed. These inputs were developed in conjunction with the simulation modelling work undertaken as part of the economic/regulatory analysis. Several sets of "do-nothing" cases were modelled. Results are shown in Table 11.

It must be kept in mind, while reviewing the results in Table 11, that these ambient impact increments already exist to a large extent. That is, the "do-nothing" curtailment policy is already in effect on pipelines serving the 54 AQCR's and the increments in Table 11 approximate the "existing" contributions of gas curtailments to ambient pollution levels. The only "new impacts" indicated in Table 11 (i.e., those due

Table 11. Potential Ambient Increments (mg/m^3) Due To Natural Gas Curtailment Under The Do Nothing Alternative

		Base Case 1981 Ave. Year		Base Case 1981 1-in-10		Base Case 1990 1-in-10		High Case 1990 1-in-10	
		SO_x	part.	SO_x	part.	SO_x	part.	SO_x	part.
019	Monroe, La.	0.66	2.47	0.82	3.05	0.67	2.26	1.06	3.65
024	Los Angeles, Ca.	0.69	2.38	0.98	3.32	0.77	2.80	1.01	3.60
030	San Francisco, Ca.	1.23	4.26	1.67	5.59	1.41	4.77	1.78	5.86
031	Stockton, Ca.	0.24	5.02	0.34	6.80	0.26	5.72	0.33	7.18
036	Denver, Colo.	0.37	0.78	0.53	1.16	0.44	0.92	0.57	1.23
056	Atlanta, Ga.	0.30	0.58	0.33	0.63	0.33	0.67	0.56	1.16
088	Cedar Rapids, Iowa	0.51	1.29	0.58	1.50	0.54	1.64	0.74	2.29
094	Kansas City, Kan.	0.32	1.52	0.38	1.85	0.32	1.40	0.52	2.29
099	Wichita, Kan.	0.76	5.35	0.93	6.54	0.60	5.02	0.99	8.32
106	Baton Rouge, La.	0.50	1.23	0.67	1.65	0.54	1.43	0.79	2.08
125	Kalamazoo, Mich.	0.23	0.93	0.30	1.20	0.21	0.94	0.35	1.62
131	Minneapolis, Minn.	0.38	1.14	0.42	1.29	0.39	1.42	0.54	1.99
153	El Paso, Tex.	0.08	0.73	0.13	1.15	0.11	1.06	0.13	1.34
162	Buffalo, N.Y.	0.81	0.14	1.02	1.18	0.92	0.11	1.67	0.20
186	Tulsa, Okla.	0.27	0.77	0.42	1.20	0.38	1.05	0.48	1.33
193	Portland, Ore.	0.94	0.25	1.05	0.29	1.18	0.34	1.45	0.42
218	Odessa, Tex.	0.39	1.41	0.60	2.20	0.55	2.07	0.69	2.61
220	Salt Lake City, Utah	0.80	0.69	0.90	0.77	1.27	0.88	1.54	1.10
229	Seattle, Wash.	0.36	0.68	0.40	0.76	0.42	0.86	0.52	1.06

to a continued do-nothing policy) are those due to demand growth and other changes which occur over time. This is seen, for example, in the comparison of the 1981 Base Case (1-in-10) with the 1990 High Case (1-in-10) results.

Several aspects of the "do-nothing" results in Table 11 are worthy of special note. First, of the 54 AQCR's under study only the 19 listed in Table 11 registered potential impacts of greater than 1 microgram per cubic meter for either sulfur oxides or particulates. This follows from the indication of the sample calculation in Table 10 that the impact potential of curtailment, at the level of the AQCR, is relatively small. It is of particular note that all of the cases summarized in Table 11 are based on conservative assumptions of 100% substitutability and relatively dirty alternate fuel preference (Table 8). In some of the higher impact cases, these impacts are explained by the heavy use of natural gas in the utility sector such as in California, Kansas, and the producing states. The curtailment of utility gas produces extremely high emissions relative to total emissions in these areas where the utility sector uses large quantities of gas. In fact, some of the utility curtailments assumed in these results may actually be covered by environmental exemptions. In the case of the AQCR's served by intrastate gas, it is probable that the curtailment assumptions on which these impacts are based are higher than actual experience. In general, curtailments to any consuming sector in an AQCR in a heavily gas dependent region tend to produce a greater percentage increase in emissions because existing emissions are lower in areas where gas is the predominant fuel.

A few other studies of natural gas curtailments have arrived at the same conclusions regarding the order of magnitude of the air pollution impact. A 1977 EPA study [8] prepared by Foster Associates concluded that the incremental emissions resulting from natural gas curtailments to major fuel burning installations (MFBI's) ranged from a few hundred (particulates) up to one or a few thousand (sulfur oxides) extra tons per year in most AQCR's. In view of the sample calculation presented in the preceding section, this level of emissions is small relative to the background in major industrial cities and would generate estimates of the potential for ambient impact in a range similar to that calculated here.

Another study of the environmental impacts of natural gas curtailment was prepared for the Public Service Commission of Wisconsin [9]. The statewide increase in emissions produced by maximum curtailment levels was estimated to be 1.3% for particulates and 3.0% for sulfur oxides. This study also considered smaller portions of the state such as AQCR's and sub-areas within AQCR's. In these smaller areas, emission increases on the order of 2 to 8% were predicted. The Wisconsin study employed more site-specific data but many of the same methods used here. These

higher impact estimates in sub-areas are a main topic of the worst case discussion following in Section C, which analyzes the sensitivity of the AQCR-level rollback analysis to this type of effect.

Another obvious conclusion from the results in Table 11 is that the differences between the cases are not very great. This, again, may be explained in terms of the sample calculation in Table 10. Simply, the results of this computation are not very sensitive to the degree of difference in some of the key inputs that distinguish the different cases. There is some evidence of sensitivity, however, to the % curtailed assumption apparent in the comparison of the 1981 Base Case (1-in-10) with the 1990 Base Case (1-in-10) results. In the Base Case, the simulation modelling performed for the economic/regulatory analysis, incorporates an assumption of gradually improving management of shortage situations between 1981 and 1990, resulting in lower curtailments. Thus, the impacts on ambient are greater for the 1981 Base Case (1-in-10). The 1990 High Case (1-in-10) results represent assumptions of high demand for gas, high levels of curtailment, and no improvement in shortage management over time. This 1990 high demand case forms the basis for the "worst case" analysis presented in section B, below. For the "probable case" impacts of the alternate policy options, evaluated in the remainder of this section, the 1981 Base Case (1-in-10) is used as a baseline for the comparisons. This case is a conservative choice for a baseline, erring on the side of higher impact.

b. The Agriculture Priority

The Natural Gas Policy Act (NGPA) made special provision for a curtailment priority for essential agricultural uses of natural gas. In terms of the environmental model outlined in the preceding sections, this would correspond to inserting a new category (4a) between the process and commercial categories, consisting of gas users previously in the process and small boiler categories:

1. Utility
2. Large Boiler
3. Small Boiler
4. Process
4a. Agriculture
5. Commercial
6. Residential

It is clear from the sample calculation in Table 10, that given the same total amount of curtailment in an AQCR, such rearrangement of priority categories will not dramatically change the effect on ambient air quality. This view, however, is too simple. A draft EIS on the proposed agriculture priority (published by USDA as part of their NGPA responsibility to certify "essential agricultural gas use") [10], pointed out that the effect of the rearrangement in priorities need not be isolated to AQCR's having a large agricultural sector but may be transmitted via pipeline allocation formulas to other users in other locations. A short-run effect may be reallocations of curtailment "along" pipelines. The USDA EIS foresees ultimate interregional reallocations of curtailment suggesting reallocations "between" pipelines as well. The short-run adjustment along heavily agricultural pipelines may produce the deepest compensating curtailments in the industrial sector and can be simulated with the environmental model. Reallocations between pipelines over the longer term would more likely have an equalizing effect on the depth of compensating industrial curtailment by spreading it out over more users.

The actual version of the environmental model was modified to simulate the effects of an agriculture priority. The percentage of agricultural gas use in each AQCR was estimated from data presented in Section VII. This amount of curtailable demand was removed from the process category and, to compensate, the percent curtailed assumptions were then increased for successive priority categories (utility, large boiler, etc.) until the total amount curtailed on each pipeline was returned to the level of the do nothing case. The results of this simulation are presented in Table 12, below. AQCR's not shown in the table had less than 1 microgram per cubic meter of potential impact. It is evident from this table that the impacts of this alternative fall in exactly the same range as the "do-nothing" alternative. The net difference between them is negligible.

The USDA EIS [10] concludes that the greatest impacts from the agriculture priority will be felt in DOE Regions 4 (South) and 7 (Great Plains). The EIS estimates that the increase in emissions in each of these regions will be in the range of 2,000 to 80,000 tons/year of particulates and 20,000 to 40,000 tons/year of sulfur oxides. The detailed basis for these estimates is not given in the USDA EIS. The lower ends of these ranges are consistent with the results in Table 12.

AQCR		Sulfur Oxides	Particulates
019	Monroe, La.	0.83	3.11
024	Los Angeles, Ca.	0.99	3.37
030	San Francisco, Ca.	1.70	5.69
031	Stockton, Ca.	0.34	6.89
036	Denver, Co.	0.52	1.17
088	Cedar Rapids, Iowa	0.70	1.76
094	Kansas City, Mo.-Kan.	0.40	1.91
099	Wichita, Kan.	0.96	6.74
106	Baton Rouge, La.	0.68	1.68
125	Kalamazoo, Mich.	0.34	1.33
131	Minneapolis, Minn.	0.52	1.56
153	El Paso, Tex.	0.13	1.15
162	Buffalo, N.Y.	1.02	0.18
186	Tulsa, Okla.	0.42	1.20
193	Portland, Ore.	1.04	0.29
218	Odessa, Tex.	0.60	2.20

TABLE 12. POTENTIAL AMBIENT INCREMENTS
DUE TO AN AGRICULTURE PRIORITY

c. The Process and Feedstock Priority

The curtailment priority categories used in the environmental model already conform to the idea of a process and feedstock priority. This proposal corresponds closely to an idealized version of the existing end use policy, i.e., where the priority system accurately segregates process users from boiler fuel users. In the do-nothing case, the emissions due to the imperfections in current priority systems are simulated by choosing higher estimates of the depth of curtailment for the process category. The emissions produced by a process and feedstock priority can be simulated by relaxing this assumption. This will have the effect of shifting some curtailment into the boiler categories and between cities on the same pipeline. The actual version of the environmental model was run with such a set of assumptions. It was assumed, based on insights from the simulation modelling of the economic/regulatory analysis, that a process and feedstock priority might reduce curtailments in the process category by 50%. Compensating deeper curtailments in other categories were calculated by the model. The results obtained are given in Table 13.

Again, only a few AQCR's display impact potential of notable proportion. Further, it is noted that the differences between the process and feedstock priority (Table 13) and the agricultural priority (Table 12) are negligible; and, that both of them represent negligible differences over the "do-nothing" case (Table 11, 1981 Base Case, 1-in-10). The reason for this result, again, relates back to the dimensions of the problem illustrated in the sample calculation in Table 10. Both the agriculture priority and process and feedstock priority are simulated in the environmental model by manipulating a portion of the demand and curtailment inputs in one or two of the consuming sectors. It simply takes a lot more than this to effect a major difference in the outcome of this calculation. Another view of this same aspect of the problem is given in Figure 4 which indicates the study finding that the slopes of most all of the impact transformation curves are very small.

AQCR		Sulfur Oxides	Particulates
019	Monroe, La.	0.96	3.53
024	Los Angeles, Ca.	1.14	3.90
030	San Francisco, Ca	2.00	6.79
031	Stockton, Ca.	0.40	8.13
036	Denver, Colo.	0.61	1.32
088	Cedar Rapids, Iowa	0.70	1.77
094	Kansas City, Kan.	0.46	2.20
099	Wichita, Kan.	1.11	7.71
106	Baton Rouge, La.	0.75	1.84
125	Kalamazoo, Mich.	0.47	1.83
131	Minneapolis, Minn.	0.52	1.55
153	El Paso, Tex.	0.13	1.15
162	Buffalo, N.Y.	1.09	0.18
186	Tulsa, Okla.	0.42	1.20
193	Portland, Ore.	1.29	0.35
218	Odessa, Tex.	0.60	2.20
220	Salt Lake City, Utah	1.10	0.93

Table 13: POTENTIAL AMBIENT INCREMENTS DUE TO A PROCESS AND FEEDSTOCK PRIORITY

d. A Percent Limit Rule

A percent limit rule -- a limit on the depth of curtailment in a given priority category -- is based on the concept that curtailment and/or fuel substitution costs are higher than average for some small percentage of the users in a category. The effect may be to shift some curtailment among the small boiler, process, or commercial categories in order to get the same absolute level of curtailment. This shift may take place in individual AQCR's as well as, to some extent, between nodes along pipelines. The percent limit rule has been simulated in the actual version of the environmental model by simply assuming 20% less curtailable demand in each consuming sector. The % curtailment factor was then increased in successive priority categories in the AQCR's on a given pipeline until the same total amount is curtailed. The results of this run are presented in Table 14. This set of assumptions produces more of a difference from the "do-nothing" case than the agriculture or process and feedstock priorities, but the differences are still small.

AQCR	Sulfur Oxides	Particulates
019 Monroe, La.	0.77	2.87
024 Los Angeles, Ca.	0.95	3.26
030 San Francisco, Ca.	1.65	5.64
031 Stockton, Ca.	0.33	6.75
036 Denver, Co.	0.51	1.10
088 Cedar Rapids, Iowa	0.58	1.49
094 Kansas City, Mo.-Kan.	0.45	2.17
099 Wichita, Kan.	1.10	7.73
106 Baton Rouge, La.	0.65	1.59
125 Kalamazoo, Mich.	0.35	1.39
131 Minneapolis, Minn.	0.42	1.27
153 El Paso, Tex.	0.14	1.24
162 Buffalo, N.Y.	1.26	0.22
186 Tulsa, Okla.	0.45	1.30
193 Portland, Ore.	1.05	0.29
215 Dallas-Ft. Worth, Tex.	0.52	1.03
218 Odessa, Tex.	0.65	2.38

Table 14: POTENTIAL AMBIENT INCREMENTS DUE TO A PERCENT LIMIT RULE

e. Pricing

A pricing or market system for allocating gas during shortages would have the same type of effect as a percent limit rule except that the limits on curtailment would be determined by the willingness-to-pay for gas in each consuming sector. This option was simulated with the actual version of the environmental model using the assumption that process and feedstock users would be most willing-to-pay for gas and that some large commercial users not now on interruptible service would not want to pay an extra premium for gas. The results are given in Table 15. As shown, the potential impacts of a pricing alternative do not differ greatly from the percent limit or the do-nothing cases.

	AQCR	Sulfur Oxides	Particulates
019	Monroe, La.	0.85	3.15
024	Los Angeles, Ca.	0.97	3.30
030	San Francisco, Ca.	1.72	5.68
031	Stockton, Ca.	0.35	6.95
036	Denver, Co.	0.55	1.21
088	Cedar Rapids, Iowa	0.76	1.88
094	Kansas City, Kan.	0.45	2.14
0.99	Wichita, Kan.	1.10	7.63
106	Baton Rouge, La.	0.69	1.70
125	Kalamazoo, Mich.	0.41	1.63
131	Minneapolis, Minn.	0.57	1.66
153	El Paso, Tex.	0.13	1.15
162	Buffalo, N.Y.	1.22	0.21
186	Tulsa, Okla.	0.42	1.20
193	Portland, Ore.	1.40	0.37
218	Odessa, Tex.	0.60	2.20
220	Salt Lake City, Utah	1.19	1.01

Table 15: POTENTIAL AMBIENT INCREMENTS
DUE TO A PRICING OPTION

f. Beyond Curtailment - Combining with other Energy Policy.

Alternatives involving combining natural gas curtailment policies with other energy management policies are discussed in the economic/regulatory analysis. The primary candidate in this category of options, modified rate structures, would be simulated in the environmental model with input assumptions almost the same as the pricing option studied immediately above. The results would therefore be very similar.

JFA

g. Rolling Base and Pro-Rata Options

A rolling base option would provide for a regular updating of the baseline data used to implement the end use priority "467-B policy". A pro-rata option would allocate gas shortages to users on a pro-rata basis according to their volumes of use. These two types of options, perceived as having attractive equity characteristics, are found in the economic/regulatory analysis to have some unattractive features from the standpoint of administration and efficiency. A major drawback to both approaches is some increased uncertainty and a negative effect on user confidence. As winter season curtailment schemes, neither system would be likely to produce emissions impacts significantly different from those of the do-nothing alternative or the other alternatives evaluated here. There is insufficient detailed data to model the specific consequences of these alternatives. The basic dimensions of the problem summarized in the sample calculation in Table 10, however, will cause the effects of these types of minor rearrangements in priority categories on ambient pollutant concentrations to be negligible. An exception to this conclusion could come about because the negative influence of these options on user confidence might have the potential to induce a higher rate of permanent switching away from gas to alternate fuels. This could produce greater impacts on ambient air quality.

h. Improved 467-B

The existing "467-B policy" does not function perfectly to curtail gas according to successive priorities because the level of shortage (and hence the depth of curtailment) varies from one pipeline to the next, and the transfer or sale of gas between pipelines is difficult under existing regulations. A potential improvement in the 467-B system, then, would be to remove some of the obstacles to movement of gas between pipelines. This option has been simulated with the imaginary version of the environmental model in which all 54 AQCR's are treated as though they are served by one pipeline. This version of the model automatically simulates the improved 467-B option by equalizing the depth of curtailment in all AQCR's. It was used to determine how the improved 467-B option would affect the environmental performance of the "do-nothing" option, the agriculture priority, the process and feedstock priority, a percent limit, and a pricing approach. The results are given in Table 16.

As indicated in the first column of Table 16, the improved 467-B option produces the same results for the "do-nothing" case, the agriculture priority, and the process and feedstock priority. This comes about because the complete and evenly distributed

allocation of curtailment assumed in this imaginary single pipeline model brings the required level of curtailment in the small boiler category down to 20% and requires no curtailments in the process and feedstock category. The effect is to obviate the necessity of agriculture or process and feedstock priorities. It must be pointed out, however, that this imaginary single pipeline model reflects the improved 467-B system as though it worked perfectly — i.e., as though there were no barriers whatsoever to inter-pipeline transfers including obstacles of informaiton and communication. In reality, the improved 467-B option would not necessarily do the whole job of agriculture or process and feedstock priorities. There is no basis from which to develop input assumptions for a less than perfect improvement in 467-B, but it is expected that the potential emissions impacts would fall into the same order of magnitude as the simulations in Table 16.

C. Worst Case Analysis

There are three types of sensitivity tests which comprise this worst case analysis. They all can be thought of as varying the inputs or assumptions in the sample calculation presented earlier to examine the variability of the results. The three aspects of this analysis are as follows:

- variation in input data parameters due to differences between the cities under study,
- temporal variation in the values of the input parameters between 1981 and 1990,
- variation in the assumptions that structure the model of potential ambient impact.

The first of these types of variation is accounted for in every run of the environmental model by virtue of the fact that it contains individually developed data inputs for each of the 54 AQCR's under study. The highest impact levels among the 54 are noted in the outputs from each run, thus highlighting the impacts at the worst end of the range that are due in part to this type of variation.

Variation in impacts due to temporal changes in values of the inputs is assessed in two ways: (1) there are two different sets of input data for each of the 54 AQCR's representing the differences between 1981 and 1990, (2) there are three demand scenarios evaluated, representing different levels of demand, permanent switching, and winter season curtailment. The dimensions of these sources of variation are illustrated in Figure 5.

Table 16. Potential Ambient Increments Resulting From Improved 467-B

AQCR		Do-Nothing, Process and Feedstock Priority, and Agricultural Priority		Pricing		Percent Limit	
		SO_x	part.	SO_x	part.	SO_x	part.
016	Little Rock, Ark.	1.07	0.36	0.96	0.34	1.08	0.35
019	Monroe, La.	0.63	2.31	0.58	2.14	0.60	2.21
024	Los Angeles, Ca.	1.06	3.73	1.05	3.68	0.93	3.22
030	San Francisco, Ca.	1.93	6.76	1.93	6.78	1.64	5.61
031	Stockton, Ca.	0.39	7.88	0.39	7.92	0.33	6.68
036	Denver, Co.	0.58	1.19	0.58	1.21	0.51	1.08
088	Cedar Rapids, Iowa	0.39	1.03	0.43	1.13	0.38	0.98
094	Kansas City, Kan.	0.35	1.65	0.37	1.75	0.31	1.48
099	Wichita, Kan.	0.82	5.62	0.88	6.02	0.75	5.11
106	Baton Rouge, La.	1.00	2.48	0.91	2.23	0.96	2.41
125	Kalamazoo, Mich.	0.33	1.23	0.38	1.45	0.32	1.20
153	El Paso, Tex.	0.26	2.65	0.25	2.45	0.24	2.53
186	Tulsa, Okla.	0.86	3.15	0.81	2.86	0.78	3.14
214	Corpus Christi, Tex.	1.15	1.59	1.08	1.47	1.05	1.52
215	Dallas-Ft. Worth, Tex.	1.00	2.20	0.94	2.04	0.92	2.10
216	Houston, Tex.	0.38	1.19	0.35	1.06	0.35	1.15
218	Odessa, Tex.	1.25	5.08	1.18	4.70	1.12	4.85

	1981	1990
HIGH DEMAND	highest demand 2nd highest curtailment no permanent switching	2nd highest demand highest curtailment no permanent switching
BASE CASE	3rd highest demand 3rd highest curtailment 4th highest permanent switching	4th highest demand 4th highest curtailment 2nd highest permanent switching
LOW DEMAND	5th highest demand lowest curtailment 3rd highest permanent switching	lowest demand 5th highest curtailment highest permanent switching

FIGURE 5. DIMENSIONS OF TEMPORAL VARIATION

It is noted that the ranking of demands in Figure 5 pertains only to curtailable industrial demands. At first glance, it is difficult to tell which of the six cells in Figure 5 would represent a worst case. There is, in fact, no single worst case but a number of worst case combinations. The worst case impact from winter season curtailment is expected to be the high demand 1990 case. The impacts of this case given in Table 11 are found to be not too extremely different from the 1981 Base Case which was selected for the evaluation of probable impacts in Section B3, above. Not shown on Figure 5 is one more dimension of variation — that of the probability distribution for severe winter weather. The simulation model developed for the economic/regulatory analysis uses 1-in-2 year, 1-in-10 year, and 1-in-50 year events. The 1-in-10 year events were selected as a conservative assumption for all of the environmental analyses.

The worst case impact from permanent switching occurs in the low demand 1990 case. The emissions for this case were simulated with the environmental model and results are given in Table 17 for 25 of the 54 cities in which the potential ambient impact exceeded 1 microgram per cubic meter.

Comparison of the worst case of winter season curtailments with the permanent switching worst case shows that they have roughly the same levels of impact. These two sets of impacts however are mutually exclusive, because high levels of curtailment induce switching and high rates of switching reduce the need for curtailment. It is possible, however, that there may be some mix of curtailment and switching that produces a combined impact that is somewhat greater than either of these extreme cases. The base case for 1981 evaluated in Section B3, above represents one such mix of permanent switching and winter curtailments. It, however, displays less total impact than either of the two extreme cases.

	AQCR	Sulfur Oxides	Particulates
016	Little Rock, Ark.	1.20	0.77
018	Memphis, Tenn.	1.14	1.52
019	Monroe, La.	0.69	2.35
024	Los Angeles, Ca.	0.36	1.39
030	San Francisco, Ca.	0.52	1.96
031	Stockton, Ca.	0.10	2.21
056	Atlanta, Ga.	0.72	1.25
069	Quad Cities, Iowa	0.50	1.51
088	Cedar Rapids, Iowa	1.11	2.71
094	Kansas City, Kan.	0.38	2.00
099	Wichita, Kan.	0.78	8.31
106	Baton Rouge, La.	1.04	2.74
115	Baltimore, Md.	1.16	0.11
124	Toledo, Ohio	0.34	1.25
125	Kalamazoo, Mich.	0.70	4.15
131	Minneapolis, Minn.	0.44	1.46
153	El Paso, Tex.	0.20	2.07
162	Buffalo, N.Y.	1.16	0.19
174	Cleveland, Ohio	1.50	0.48
177	Lima, Ohio	1.13	0.61
186	Tulso, Okla.	0.69	3.26
214	Corpus Christi, Tex.	0.83	1.20
215	Dallas-Ft.Worth, Tex.	0.75	1.22
216	Houston, Tex.	0.34	1.05
218	Odessa, Tex.	1.02	4.07

TABLE 17. POTENTIAL AMBIENT INCREMENTS DUE TO PERMANENT FUEL SWITCHING IN THE LOW DEMAND CASE, 1990

Finally, worst case sensitivity tests must be applied not only to the data but also to the assumptions of the ambient impact model. Worst case ambient air quality impacts may be expected to occur when emissions are concentrated in a given area. The proportional rollback model used here assumes uniform mixing and uniform distribution of the emission sources throughout the entire air quality control region. It is likely however that many of the 54 AQCR's contain one or more distinct sub-areas where industrial land use is concentrated.

A case in point is the study mentioned in Section B that was performed for the Wisconsin Public Service Commission [9]. The results of this study were presented as percent increases in emissions, which implies the same thing as the rollback model. At the state level, maximum curtailment was estimated to produce a 1.3% increase in particulate emissions and a 3.0% increase in sulfur oxide emissions. In some AQCR's, however, the impact estimates were on the order of 2 to 4% for particulates and 6 to 7% for sulfur oxides. An increase of 8% in particulate emissions was calculated for one sub-area of an AQCR.

A worst case simulation of the potential impact of this effect of concentrated industrial land use was designed about the following hypothetical assumptions:

- Consider an industrial area within an AQCR that occupies 20% of the total land area and contains 50% of the industrial sector. This area therefore contains only 20% of the existing emissions from background and transportation sources and only 50% of the existing industrial emissions.
- The industrial area contains only 5% of the commercial and residential development in the AQCR and thus only 5% of the existing emissions from these sources.
- The local utility plant is located elsewhere so that the existing emissions from the utility sector are not contained in this area.
- All of the industrial gas curtailment and/or permanent fuel switching in the AQCR takes place in this one industrial area.

This set of assumptions is intended to produce extreme worst case emissions in all 54 AQCR's. The high demand 1990 case (highest winter curtailments) and the low demand 1990 case (greatest permanent fuel switching) were rerun with these severe assumptions to fully brackett the outside range of extremes. The results of these extreme worst cases are summarized as follows:

- Permanent Switching - low demand, 1990
  - sulfur oxides -
    - 44 of 54 cities show ambient increments exceeding 1 microgram per cubic meter
    - average increment of the 44 cities is 4.6 ug/m^3
    - highest increment is 20.8 ug/m^3
    - 6 cities show increments over 10 ug/m^3

- particulates
  - 39 of 54 cities show ambient increments exceeding 1 microgram per cubic meter
  - average increment of the 39 cities is 4.7 ug/m^3
  - highest increment is 26 ug/m^3
  - 3 cities show increments over 10 ug/m^3

- Winter Season Curtailments - high demand, 1990
  - sulfur oxides
    - 32 of 54 cities show ambient increments exceeding 1 microgram per cubic meter
    - average increment of the 32 cities is 3.4 ug/m^3
    - highest increment is 12.6 ug/m^3
    - 3 cities show increments over 10 ug/m^3
  - particulates
    - 24 of 54 cities show ambient increments exceeding 1 microgram per cubic meter
    - average increment of 3.6 ug/m^3
    - highest increment is 18.7 ug/m^3
    - 1 city shows an increment over 10 ug/m^3

The chance that this extreme set of assumptions approximates reality in all of these 54 cities is not great. It is probable, however, there are sub-areas within some of these AQCR's where emissions caused directly or indirectly by natural gas curtailment are more concentrated. Thus, an additional conclusion must be added to the assessment of "probable impacts" in Section B — i.e., that there will be some localized exceptions at the sub-AQCR level to conclusions indicated by the AQCR level rollback calculations.

Another factor not accounted for in the rollback model which affects the concentration and dispersion of emissions is, of course, the wind. In particular, winter inversions, concentrating local emissions are known to occur in many areas affected by winter season curtailments. The emission dispersion plumes from pollution sources can also concentrate emissions at points along the paths they follow. Thus, the conclusion that there will be localized exceptions to the ambient impact potential indicated by the rollback model is reinforced by these considerations. Whether the emissions become more dispersed or more concentrated is literally a function of how hard the wind is blowing. It is possible that some areas may experience poor dispersive conditions on a regular basis throughout the winter season. Simultaneous conditions of high levels of curtailment and poor dispersion would be the most important exceptions to the general rollback analysis.

D. Best Case Analysis

The construction of probable, best, and worst cases in the evaluation of any DOE fossil fuel policy is complicated somewhat by the fact that EPA and State air quality agencies regulate emissions from fossil fuel combustion. This situation is depicted in Figure 6, below.

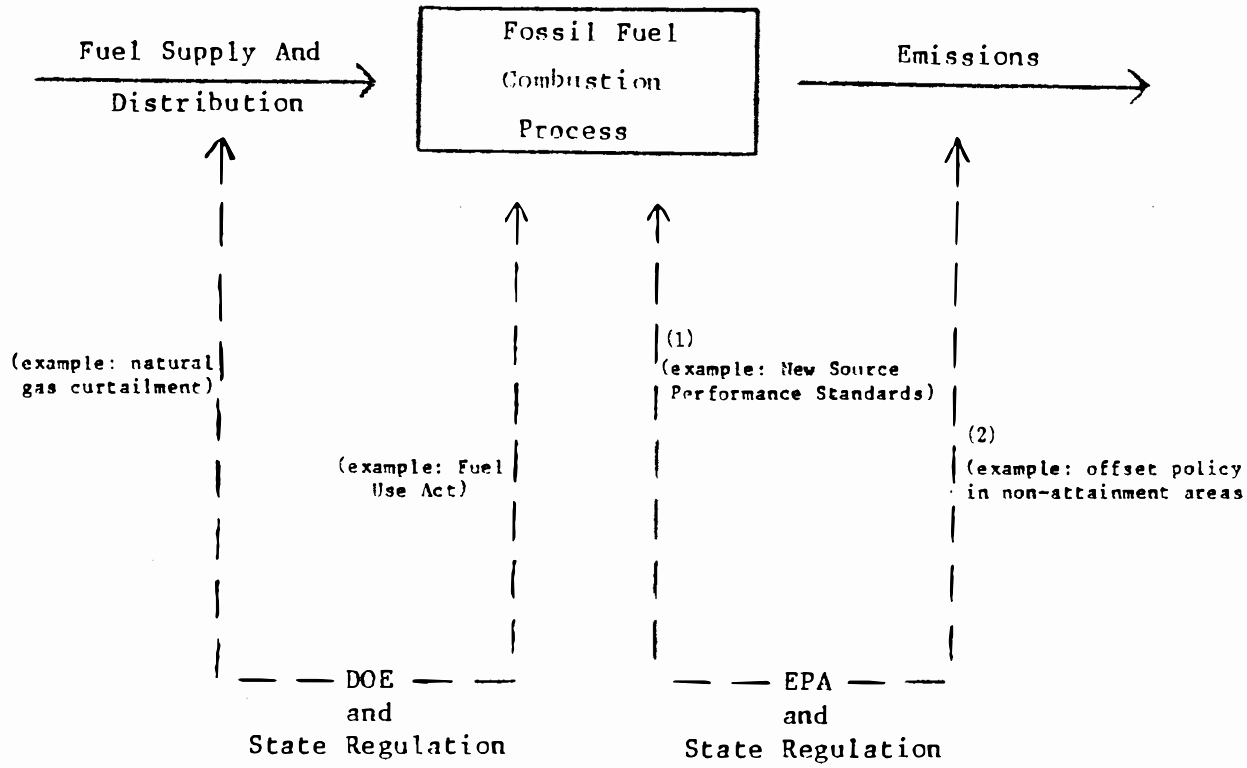

FIGURE 6: FOSSIL FUEL REGULATORY RELATIONSHIPS

Generally speaking, pollution regulations take the form of limits on the emission rate (1) or limits on the total quantity of emissions (2). They thus, have the effect of either filtering (1) or blocking (2) the impacts that might otherwise result from a given DOE fuel policy. In either case, there may be a feedback effect causing fuel users to modify their response to DOE policy. This can result, for example, when a course of action such as a fuel switch is either prohibited outright or prohibitively expensive due to control requirements.

To take a specific example, the extreme worst case impacts of permanent fuel switching estimated in the preceding section would probably not be realized due to the constraints imposed by EPA and State air quality regulations. Two general types of regulations most affecting this situation are the "Non-Attainment" policies and the "Prevention of Significant Deterioration" policies.

In broadest outline, the non-attainment policy would prohibit permanent switching to alternate fuels in many areas that already have relatively bad air quality. Or, permanent switching may be allowed if the user can somehow bring about a reduction in the total emissions of the non-attainment area that will offset the emission increase generated by the fuel switch. The prevention of significant deterioration policy places an upper limit on emission increases, such as those from permanent fuel switching, in areas where the existing air quality is relatively good.

These two types of air quality constraints would have the effect of reducing the total amount of permanent switching. They make the low demand scenario seem less likely than the base case.

In similar fashion, a best case may be constructed for the winter season curtailment part of the problem by simply imitating these two EPA policies. From a common sense standpoint, the question of how to manage gas curtailment so as to minimize the air quality impact boils down to a simple set of rules, like the following:

- don't curtail in areas where the air quality is already particularly bad;
- instead, reduce gas deliveries in areas that have some available assimilative capacity;
- but, reduce gas deliveries in a manner which distributes the use of assimilative capacity equally among cleaner air areas.

This set of rules corresponds directly to the EPA Non-Attainment and Prevention of Significant Deterioration policies. In effect, the optimal environmental curtailment policy would be for DOE to manage the lefthand side of Figure 7(winter season curtailment), above, according to the same principles that EPA applies to the righthand side (permanent fuel switching).

In a 1974 article entitled, "An Air Quality Approach to Natural Gas Curtailment" [11], Dr. Noel de Nevers and Dr. Albert Wehe outlined what is probably the most vigorous approach to this type of environmental optimum. They reported the results of a simulation modelling analysis of the concept of allocating gas along a pipeline on a day-by-day basis according to an index of the air dispersion characteristics (the pollution potential) in the major cities served. This index can be reliably forecast 24 hours in advance. The advantages and disadvantages of this approach are as follows:

- Advantages:
  (1) The allocation rules are not based on existing "ambient" air quality and, so, do not reward polluters with extra gas.
  (2) The daily simulation approach maximizes the air quality benefit by fully accounting for the variation in atmospheric conditions.
- Disadvantages:
  (1) The day-to-day allocation of gas may cause massive permanent fuel switching among users who cannot adapt to such day-to-day uncertainties.
  (2) The optimal solutions determined for individual pipelines may be sub-optimal* for the pipeline system as a whole.

The disadvantages of the day-to-day approach make it an unfeasible and possibly undesireable environmental best case policy. The approach selected in this analysis is to try to avoid the first disadvantage (uncertainty and permanent switching) by taking a winter season instead of a day-to-day approach. This unfortunately compromises both of the advantages of the approach as the average ambient level in the major cities is the most accessible indicator on which to base a seasonal approach.

The second type of disadvantage (the risk of sub-optimizing) is a threat to any attempt to find a best environmental curtailment strategy. There are two types of sub-optimal conditions. The first is due to the fact that major cities may be served by as many as four or five pipelines. Thus if each pipeline is optimized individually to deliver gas to the cities it serves on the basis of comparative air quality conditions, the solution may not turn out to be optimal when the system interconnections are taken into account. Some cities will get more than they need and some will get less. The second type of sub-optimal condition is related to the phenomenon known as long range transport. This is where pollutants generated in one location (say, the midwest) ultimately drift over downwind locations (the northeast). From the standpoint of trying to find an optimal environmental curtailment strategy, this complication due to long range transport may be thought of as overlaying another "pipeline network" on this already complicated problem which transports the pollution from city to city. The mechanisms of this last pipeline system are not very well understood at present.

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*"Sub-Optimal" describes a solution which appears optimal only because some larger aspect of the problem has not been taken into account.

A truly optimal environmental curtailment strategy would have to fully account for pipeline interconnections and long range transport in order to avoid sub-optimization. The day-to-day approach suggested by de Nevers and Wehe would entail significant enough quantities of gas that these sub-optimal conditions could probably not be avoided. To fully account for these effects in a national level optimization model to be generated on a daily basis would be an enormously difficult task.

For these reasons of the risk of permanent switching and the risk of sub-optimizing, the day-to-day approach to an environmental optimum is not adopted for this analysis. Instead, the search for a best environmental policy is conducted on a winter season basis. It is reasoned that a winter season approach might be formulated in a more stable set of curtailment rules that might not induce as much loss of user confidence and permanent switching. Also, from the generally small impacts indicated by the foregoing probable and worst case analyses, it is known that the amounts of gas involved in a winter season strategy might not be as drastic as those required in a day-to-day system which may make sub-optimization less likely or less severe.

To conduct the winter season search for a best environmental pattern of curtailment, ambient constraints representing non-attainment and prevention of significant deterioration policies were added to both versions of the environmental model (see "A" in Figure 4). An ambient ceiling was imposed near the level of the National Secondary Ambient Air Quality Standard for sulfur oxides and for particulates. For those ACQR's under these ceilings, a constraint was imposed on the size of the incremental increase in ambient concentration.

To find an optimal environmental allocation of curtailment, the imaginary single pipeline version of the model is run with an ambient impact ceiling fixed at the lowest possible level while the allowable increment of additional ambient impact for cities below the ceiling is varied until the total amount curtailed is equal to that required in the case under study. The resulting set of ceiling and increment constraints are then plugged into the actual version of the model which allocates curtailment according to the actual interconnected pipeline network. Differences in the curtailments allocated by these two versions of the model indicate conditions in which two or more pipelines are competing for the ambient capacity (or "curtailment capacity") in a jointly-served AQCR. This means that the optimal solutions for the individual pipelines may not be optimal for the pipeline system as a whole.

The 1990 High Demand (1-in-10) "do-nothing" case is used to conduct this search for a best environmental allocation of curtailment. Table 18 gives a side-by-side comparison of the unconstrained ambient impacts of this case versus the impacts of the same case under an optimal set of ambient constraints. The constraints used in the imaginary single pipeline model were an ambient ceiling for particulates of 52 ug/m^3 and an allowable increment of 1.0 ug/m^3. It is noted that these runs are based on projected 1990 ambient levels. Many of the AQCR's curtailed would not now be under the ambient ceiling but are projected to be under it by 1990.

The constrained case in Table 18 shows a reversal of the pattern of impacts in heavily gas dependent regions such as California, Kansas, and the producing states. These areas are perhaps most susceptible to ambient impacts from curtailment because gas is a predominant fuel. Substitute fuel use is therefore a larger proportion of total emissions in these areas.

This best environmental case shows some potential for ambient improvements from an optimal pattern of curtailment. This might be a difficult allocation to achieve in practice, however, and the net gain would be less in the more probable Base Case than in the extreme High Demand Case examined here.

In the second part of this best case analysis, the same constraints plugged into the actual version of the model produced warnings of potential sub-optimal conditions for 9 AQCR's. The excess demand for the ambient capacity in these AQCR's generally amounted to less than 1 microgram per cubic meter, however. This effect would also tend to be less noticeable in the more probable Base Case than in the High Demand Case examined here.

The results of this best case analysis converge upon a simple conclusion: It does not seem worthwhile to base curtailment policy on air quality criteria at the programmatic level. This is based on the following:

- Best environmental policies do not gain much in the most probable case, especially if measured against the conceivable problems of implementing such reallocations.

Table 18. Comparison of Constrained and Unconstrained Cases

AQCR	1990 HIGH CASE UNCONSTRAINED SO_x	1990 HIGH CASE UNCONSTRAINED Part.	1990 HIGH CASE AMBIENT CONSTRAINTS SO_x	1990 HIGH CASE AMBIENT CONSTRAINTS Part.
004 Birmingham, Ala.	0.51	0.48	0.65	0.72
005 Mobile-Pensacola	0.14	0.54	0.24	1.00
007 Florence, Ala.	0.05	0.11	0.09	0.26
016 Little Rock, Ark.	0.47	0.19	0	0
018 Memphis, Tenn.	0.13	0.30	0	0
019 Monroe, La.	1.07	3.65	0	0
024 Los Angeles, Ca.	1.01	3.60	0	0
030 Sna Francisco, Ca.	1.78	5.86	0.28	1.00
031 Stockton, Ca.	0.33	7.18	0	0
036 Denver, Co.	0.57	1.23	0	0
038 Pueblo, Co.	0.62	0.61	0.98	1.00
043 New York, N.Y.	0.05	0.13	0.30	0.69
045 Philadephia, Pa.	0.15	0.29	0.37	0.70
053 Augusta, Ga.	0.60	0.71	0.76	1.00
055 Chattanooga, Tenn.	0.31	0.77	0.38	1.00
056 Atlanta, Ga.	0.55	1.16	0	0
067 Chicago, Ill.	0.34	0.28	1.00	0.65
069 Quad Cities, Iowa	0.05	0.31	0.29	1.00
070 St. Louis, Mo.	0.63	0.85	0	0
078 Louisville, Ky.	0.07	0.07	0.62	0.83
079 Cincinnati, Ohio	0.10	0.04	0.81	0.66
080 Indianeapolis, Ind.	0.26	0.18	0	0
088 Cedar Rapids, Iowa	0.74	2.29	0.34	1.00
094 Kansas City, Kan.	0.51	2.29	0	0
099 Wichita, Kan.	0.99	8.32	0	0
103 Huntington, W. Va.	0.03	0.03	0.24	0.51
106 Baton Rouge, La.	0.79	2.08	0	0
115 Baltimore, Md.	0.19	0.03	1.00	0.15
122 Grand Rapids, Mich.	0.08	0.10	0.25	0.61
123 Detroit, Mich.	0.21	0.21	0	0
124 Toledo, Ohio	0.11	0.36	0.31	1.00
125 Kalamazoo, Mich.	0.35	1.62	0	0
131 Minneapolis, Minn.	0.54	1.99	0	0
153 El Paso, Tex.	0.13	1.34	0	0
162 Buffalo, N.Y.	1.67	0.20	1.00	0.11
173 Dayton, Ohio	0.19	0.09	1.00	0.55
174 Cleveland, Ohio	0.44	0.14	1.00	0.32
176 Columbus, Ohio	0.06	0.08	0.51	1.00
177 Lima, Ohio	0.24	0.11	1.0	0.59
178 Youngstown, Ohio	0.26	0.07	1.00	0.30
181 Steubenville, Ohio	0.94	0.52	0.79	0.81
186 Tulsa, Okla.	0.48	1.33	0	0
193 Portand, Ore.	1.45	0.42	1.00	0.28
197 Pittsburgh, Pa.	0.39	0.34	1.00	0.93
208 Nashville, Tenn.	0.06	0.14	0.08	0.22
214 Corpus Christi, Tex.	0.57	0.80	0	0
215 Dallas-Ft. Worth, Tex.	0.50	0.78	0	0
216 Houston, Tex.	0.20	0.58	0	0
218 Odessa, Tex.	0.69	2.61	0	0
220 Salt Lake City, Utah	1.54	1.10	0	0
229 Seattle, Wash.	0.52	1.06	0	0
234 Charleston, W. Va.	0.12	0.04	1.00	0.36
237 Appleton-Oshkosh, Wisc.	0.04	0.06	0	0
239 Milwaukee, Wisc.	0.06	0.26	0	0

- There is some evidence that seasonal optimizing for air quality at the next lowest level (i.e., the pipeline) may entail some sub-optimization, but the magnitude and extent of this error seems limited, probably correctable.

- The low levels of extra ambient increments that would be required in some locations to effect this type of best policy do not seem to pose too great a threat of sub-optimization in terms of the potential side effects of long range transport. This is, however, subject to some uncertainty.

The alternative best environmental policy is to relate natural gas curtailment to air quality criteria below the programmatic level. Under current practice, FERC (The Federal Energy Regulatory Commission) approves the curtailment plans of individual pipelines in the course of which an environmental impact statement is prepared. The results derived in this best case analysis would support the view that the FERC environmental review of individual pipelines should be continued for the purpose of evaluating requests for exemptions to curtailment rules on the basis of extreme environmental conditions. This conclusion is supported by the following:

- Special attention can be given to heavily gas dependent regions that are more susceptible to ambient impact from curtailment.

- All conceivable types of localized exceptions and special cases can be handled by an exemption procedure, assuring that these impacts do not go unmitigated.

- It appears that exemptions can be evaluated on a pipeline basis without too great a risk of sub-optimizing.

The FERC staff is well equipped with the proper site-specific dispersion models to bring to bear on this problem. This level of rigorous analysis can assure that an exemption is afforded adequate review of the possible environmental impacts.

A final point on the potential utility of an exemption procedure concerns the promised evaluation of gas curtailment impacts in smaller gas-using cities (smaller gas use than the 54 AQCR's studied in detail) and rural areas. The case of small cities and rural areas is taken up in detail in Section E below. In a number of these areas the existing emissions profile is of a much lesser order of magnitude than in the large cities. In

those special cases where there is a high proportion of curtailable gas in the fuel use profile against such a background of lower total emissions, the ambient impact of natural gas curtailment might be greater. This is another type of special case impact that can be avoided by an exemption procedure.

An alternative to the FERC exemption procedure might be to leave the responsibility for certifying exemptions entirely up to states. State governments can regulate both the righthand and the lefthand sides of Figure 6. This places them in a unique position to implement an optimal solution. The study performed for the Wisconsin Public Service Commission [9] considered a best environmental case which showed that there are some potential gains in attainment status and implementation strategy to be won from intra-state curtailment policy. State air quality agencies are afterall in the best position to evaluate site-specific conditions that can contribute to exceptionally concentrated impacts from natural gas curtailment.

Despite these advantages, however, states are constrained to work with the amount of gas at their disposal. Hence, an entirely state level policy for evaluating exemptions would have some sub-optimal results. For this reason, there must be a federal role in evaluating exemptions such as that proposed for FERC. An alternative to this particular federal/state combination however, would be DOE sanction of futures or spot markets for gas coupled with State/EPA operation of local markets for pollution rights. While this may sound at first like an off-the-wall economic-theoretic approach, it is actually not too far-fetched. The DOE role could be fulfilled by several of the different types of pricing options under consideration and, as many observers have noted, the present configuration of State and EPA air regulatory programs (diagrammed in Figure 6) nearly amounts to a system of pollution rights. In the context of this alternative, a State air regulatory agency would identify unfavorable concentrations of curtailable emission sources and set control requirements for alternate fuel use steep enough to induce these users to bid for gas rather than switch fuels. In a recent development, EPA has approved the use of a "bubble policy" for existing sources under which only the total emission rate for a plant (vs. the rate for each stack or source within the plant) is regulated. This gives industry much greater flexibility in complying with regulations and could enhance the incentives to bid for gas as part of an overall pollution control strategy. Actual pollution right systems have also been the subject of recent interest within EPA.

This alternative points out an advantage of a pricing option not apparent in the preceding national and AQCR-level analyses. Such a pricing option may afford a precise means of identifying and resolving needs for environmental exemptions to gas curtailments. Though such a system would not be trouble-free, it seems worthy of being carried in any further analyses of pricing options.

E. Other Air Quality Concerns

1. Small Gas-Consuming Cities and Non-Metropolitan Areas

The list of 54 large gas-consuming urban AQCR's was developed by combining data for 100 different Standard Metropolitan Statistical Areas (SMSA's), many of which are contained within a common AQCR. The 100 SMSA's, taken together, account for 89% of total industrial gas use in SMSA's and 61% of total industrial gas use in the nation. This selection process left a second list of 88 smaller gas-consuming SMSA's which account for another 10% of total industrial gas use in SMSA's and 7% of total industrial gas use in the nation.

Due to the lesser quantity of gas involved and smaller populations exposed, it was expected that the impacts of alternate curtailment policies in these smaller gas-consuming cities may be less important at a programmatic national level than the impacts in the 54 AQCR's. The amount of gas required to ameliorate any extreme impacts of curtailment in these cities may not be as likely to require major adjustments in national patterns of gas distribution. This presumption was supported by the fact that the 88 SMSA's are distributed regionally in much the same way as the 54 AQCR's.

However, it was nonetheless recognized that the air quality impacts of curtailment in these cities may be locally important, especially when gas is a large percentage of total fuel use. In cases where gas is the predominant fuel and the emissions from other sources are not of great magnitude, the same conservative assumptions used earlier regarding alternate fuel use (100% substitution capability and dirty fuel preference) indicate that the ambient impact of curtailment may be proportionately greater than that shown in the larger industrial cities. Those smaller gas-consuming cities meeting these conditions, may be more susceptible to ambient impact from curtailment per se — i.e., regardless of the choice of federal curtailment policy. Depending on the distribution of industrial users by priority category, there may be some of these special

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cases which are more susceptible to ambient impact than others under different curtailment policy alternatives. For example, a process and feedstock priority may produce extreme impacts in a city where, in addition to the above special case stipulations, the bulk of the industrial demand is comprised of boiler fuel users. On the other hand, there may be almost no impact from such a policy in a case where the bulk of the demand is comprised of process and feedstock users.

Available data resources are not adequate to facilitate analysis of the 88 smaller gas-consuming SMSA's in the same level of detail as that applied to the 54 large gas-consuming AQCR's. It was possible, however, to estimate the percentage of industrial fuel use in these 88 SMSA's which is comprised of natural gas. A relatively high value for this parameter is a necessary condition for all of the types of special cases discussed above. Table 19 shows that the percentage of gas to other fuels is over 50%, averaging 52%, in roughly half of the 88 small gas-consuming cities. For the 54 large gas-consuming AQCR's, the average percentage is 61%. Percentages for some of the 54 AQCR's are given in Table 20. It is shown that these AQCR's with the highest percentages are the same ones for which larger impacts were forecasted.

By comparison to the large cities, then, the smaller gas-consuming cities are not, on average, as dependent upon gas. However, a significant number of them are rather dependent upon gas. Some of these cities will no doubt exhibit some of the characteristics of the special cases discussed above and may be considered as candidates for an environmental exemption procedure.

The percentages in Table 19 show that the heavily dependent small gas-consuming cities follow roughly the same geograhic distribution as the heavily dependent large gas-consuming AQCR's. There is a concentration of them in the southwest and the gas-producing states. Some of these may be served by intra-state gas and not as subject to curtailment.

No similar estimates could be prepared for non-metropolitan or rural areas due to the fact that this would require plant-specific data. The same sort of findings as those for the small gas-consuming cities may be extended to these areas, however. In general, the impacts in these areas may not be as important at a programmatic or national level due to the remoteness of the pollution sources. However, there will be exceptional cases where the local impact potential is important and may warrant treatment through an exemption procedure.

TABLE 19. - FUEL USE IN 88 SMALL GAS-CONSUMING SMSA's

	SMSA	Gas Use (A)	Fuel Use (B)	% (A÷B)
1.	Albany, Ga.	3.1	4.2	.74
2.	Albany-Schenectady-Troy, N.Y.	3.0	33.6	.09
3.	Albuguerque, N.Mex.	2.8	3.8	.74
4.	Alexandria, La.	4.5	4.8	.94
5.	Allentown-Bethlehem-Easton, Pa., N.J.	7.9	58.8	.13
6.	Amarillo, Tex.	6.0	6.5	.92
7.	Anderson, Ind.	2.6	8.7	.30
8.	Billings, Mont.	5.1	5.7	.90
9.	Bloomington-Normal, Ind.	1.1	1.2	.97
10.	Boston, Mass.	6.0	34.8	.17
11.	Bristol, Conn.	1.0	2.0	.50
12.	Brownsville-Harlingen-San Benito, Tex.	7.9	11.2	.71
13.	Champaign-Urbana-Rantoul, Ill.	3.3	4.0	.83
14.	Charlotte-Gastonia, N.C.	5.5	15.5	.36
15.	Columbia, S.C.	4.0	6.8	.59
16.	Columbus, Ga.-Ala.	6.9	11.5	.60
17.	Des Moines, Iowa	8.7	13.1	.66
18.	Dubuque, Iowa	3.7	5.6	.66
19.	Elmira, N.Y.	3.2	4.7	.68
20.	Eri, Pa.	8.2	19.5	.42
21.	Evansville, Ind.-Ky.	7.6	18.6	.41
22.	Fayetteville-Springdal, Ark.	2.4	2.8	.86
23.	Fort Smith, Ark.	4.4	5.2	.85
24.	Fort Wayne, Ind.	7.9	13.8	.57
25.	Great Falls, Mont.	1.7	2.0	.85
26.	Greensboro-Winston-Salem Highpoint, N.C.	5.6	22.5	.25
27.	Greenville-Spartanburg, S.C.	7.2	21.	.33
28.	Harrisburg, Pa.	5.3	13.9	.38

(continued)

TABLE 19. - CONTINUED

	SMSA	Gas Use (A)	Fuel Use (B)	% (A÷B)
29.	Hartford, Conn.	2.7	11.7	.23
30.	Jacksonville, Fla.	4.9	31.3	.16
31.	Johnstown, Pa.	6.6	8.4	.79
32.	Knoxville, Tenn.	5.9	16.7	.35
33.	Lafayette-West Lafayette, Ind.	3.0	7.9	.38
34.	Lakeland-WinterHaven, Fla.	2.6	10.1	.26
35.	Lancaster, Pa.	5.0	13.5	.37
36.	Las Vega, Nev.	5.8	7.9	.73
37.	Lincoln, Nebr.	1.4	2.3	.61
38.	Lowell, Mass-N.H.	1.2	2.5	.48
39.	Lubbock, Tex.	1.7	1.9	.90
40.	Lynchburg, Va.	2.4	8.7	.28
41.	Macon, Ga.	9.5	14.2	.67
42.	Madison, Wisc.	2.4	3.6	.67
43.	Mansfield, Ohio	7.0	9.9	.71
44.	Miami, Fla.	1.7	6.7	.25
45.	Montgomery, Ala.	4.9	6.4	.77
46.	Muncie, Ind.	3.7	5.9	.63
47.	New Haven-W.Haven, Conn.	1.4	9.5	.15
48.	Norfolk-Va.Beach-Portsmouth, Va.	1.7	6.4	.27
49.	Northeast Pa., Pa.	4.6	11.1	.41
50.	Oklahoma City, Okla.	5.6	7.3	.77
51.	Omaha, Nebr.	7.0	11.0	.64
52.	Orlando, Fla.	1.5	3.0	.50
53.	Owensboro, Ky.	2.7	4.8	.56
54.	Parkersburg-Marietta, W.Va.-Ohio	5.8	29.6	.20
55.	Pettersburg-Colonia Hgts.-Hopewell, Va.	5.4	23.2	.23
56.	Phoenix, Ariz.	5.2	9.6	.54
57.	Pittsfield, Mass.	1.0	7.7	.13

(continued)

TABLE 19. - CONTINUED

	SMSA	Gas Use (A)	Fuel Use (B)	% (A÷B)
58.	Providence-Warwick-Pawtucket, R.I.-Mass.	4.4	18.5	.24
59.	Reading, Pa.	5.1	15.5	.33
60.	Reno, Nev.	1.0	1.9	.53
61.	Richland=Kennewick, Wash.	3.1	6.7	.46
62.	Richmond, Va.	4.0	19.1	.21
63.	Rochester, N.Y.	7.5	40.2	.19
64.	Rockford, Ill.	8.2	10.3	.80
65.	Sacramento, Calif.	9.7	11.6	.84
66.	St. Cloud, Minn.	1.3	2.9	.45
67.	Salinas-Seaside-Monterey, Calif.	9.6	10.3	.93
68.	San Diego, Calif.	3.3	4.8	.69
69.	Santa Cruz, Calif.	2.4	2.9	.83
70.	Shreveport, La.	9.7	23.3	.42
71.	Sioux City, Iowa-Nebr.	6.8	8.4	.81
72.	South Bend, Ind.	3.9	6.3	.62
73.	Springfield, Ill.	1.2	2.3	.52
74.	Springfield, Mo.	3.0	3.9	.77
75.	Springfield-Chicopee-Holyoke, Mass.-Conn.	2.5	12.9	.19
76.	Syracuse, N.Y.	9.9	35.0	.28
77.	Tampa-St.Petersburg, Fla.	8.3	21.3	.39
78.	TerreHaute, Ind.	6.7	16.1	.42
79.	Texarkana, Tex.-Ark.	8.4	12.6	.67
80.	Topeka, Kan.	2.0	4.4	.46
81.	Tucson, ARiz.	3.9	5.0	.78
82.	Vineland-Millville-Bridgeton, N.J.	4.6	15.4	.30
83.	Waco, Tex.	6.5	7.9	.82
84.	Washington, D.C., Md., Va.	2.3	5.5	.42
85.	Waterburg, Conn.	1.5	4.4	.34
86.	Worcester, Mass.	2.2	8.0	.28
87.	Yakima, Wash.	2.9	5.4	.54
88.	York, Pa.	3.4	21.1	.16

TABLE 20. GAS USE AS PERCENT OF TOTAL INDUSTRIAL FUEL USE IN SELECTED LARGE GAS-CONSUMING AQCR'S

AQCR		Gas % of Total Industrial Fuel Use
004	Birmingham, Ala.	65.0
007	Florence, Ala.	79.3
016	Little Rock, Ark.	80.0
018	Memphis, Tenn.	62.5
019	Monroe, La.	96.8
024	Los Angeles, Ca.	73.4
030	San Francisco, Ca.	86.4
031	Stockton, Ca.	76.1
036	Denver, Co.	82.4
038	Pueblo, Co.	91.0
055	Chattanooga, Tenn.	63.8
056	Atlanta, Ga.	63.9
067	Chicago, Ill.	50.8
069	Quad Cities, Iowa	59.1
070	St. Louis, Mo.	59.9
088	Cedar Rapids, Iowa	67.8
094	Kansas City, Kan.	74.1
099	Wichita, Kan.	92.1
106	Baton Rouge, La.	92.0
122	Grand Rapids, Mich.	64.2
123	Detroit, Mich.	55.4
124	Toledo, Ohio	59.5
125	Kalamazoo, Mich.	53.7
153	El Paso, Tex.	77.4
173	Dayton, Ohio	51.8
176	Columbus, Ohio	53.2
177	Lima, Ohio	70.6
178	Youngstown, Ohio	50.6
186	Tulsa, Okla.	90.9
193	Portland, Ore.	61.5
208	Nashville, Tenn.	56.2
214	Corpus Christi, Tex.	87.8
215	Dallas-Ft. Worth, Tex.	88.2
216	Houston, Tex.	91.7
218	Odessa, Tex.	78.5
220	Salt Lake City, Utah	74.9
229	Seattle, Wash.	57.6
237	Appleton-Oshkosh, Wisc.	50.6
239	Milwaukee, Wisc.	80.1

In both the small gas-consuming cities and the non-metropolitan areas which appear to require special case treatment for the reasons described above, the case for an exemption may be further strengthened by economic arguments. In such places where the local economy is small and heavily dependent upon gas the local economic impact of curtailment can also be exceptional. The NGPA gives FERC authority under Section 502 to waive provisions of curtailment rules in cases of "special hardship". This may be defined in economic or environmental terms; or, in terms of both considerations.

2. Other Air Pollutants

As was noted in the beginning of Section V, the problem of natural gas curtailment bears most heavily upon concerns for sulfur dioxides and particulates. Natural gas is commonly thought of as a very clean fuel in terms of these pollutants. Natural gas is also very clean burning in terms of hydrocarbons (HC) and carbon monoxide (CO) due to the near completeness of the combustion process. This same feature, however, can produce high combustion temperatures (desirable for some uses) which results in the oxidation of atmospheric nitrogen to form nitrogen oxides (NO_x).

Alternate fuels tend to produce much greater quantities of particulates and sulfur oxides, about the same levels of HC and CO, and comparable levels of NO_x. For these reasons curtailment policy was not expected to make much of a difference in ambient HC, CO, or NO_x. This hypothesis was tested by inserting emission coefficients for the three pollutants into the environmental model described earlier and running the do-nothing case for the base case demand (1-in-10) for 1981. The results, presented in Table 21, are convincing — the highest value being a one-half of one percent increase in emissions. Results for CO are not shown as they were simply too negligible (less than a tenth of a percent).

3. Long-Range Transport/Acid Rain

As mentioned in the best case analysis of Section D above, environmental analysis of curtailment policy must take account of the fact that pollutants, after being generated and locally dispersed at a given location, might also be transported from that location to another. This problem has been termed "long-range transport", the most prominent manifestation of which is the acid rain (sulfuric and nitric acid formed from SO_x and NO_x) that has affected a number of remote non-industrialized regions. Another smaller scale example is the drift of background levels of pollutant concentration from one area into an adjacent area (say, from Ohio into Pennsylvania).

TABLE 21. - PERCENT INCREASES IN EMISSIONS OF NITROGEN OXIDES AND HYDROCARBONS FOR THE DO-NOTHING CASE

	AQCR	Nitrogen Oxides (%)	Hydro-carbons (%)
004	Birmingham, Ala.	.11	.15
019	Monroe, La.	.13	.15
024	Los Angelex, Ca.	.19	.05
030	San Francisco, Ca.	.50	.09
031	Stockton, Ca.	.41	.07
036	Denver, Co.	.17	.05
038	Pueblo, Co.	.19	.07
053	Augusta, Ga.	.16	.10
055	Chattanooga, Tenn.	.09	.10
070	St. Louis,Mo.	.13	.11
088	Cedar Rapids, Iowa	.18	.12
094	Kansas City, Kan.	.24	.11
099	Wichita, Kan.	.25	.11
106	Baton Rouge, La.	.16	.08
131	Minneapolis, Minn.	.13	.08
162	Buffalo, N.Y.	.22	.11
186	Tulsa, Okla.	.13	.03
193	Portland, Ore.	.12	.09
214	Corpus Christi, Tex.	.21	.04
218	Odessa, Tex.	.15	.02
220	Salt Lake City, Utah	.13	.08
229	Seattle, Wash.	.13	.07

This raises questions of the type: "Can gas curtailment in St. Louis also affect air quality in Indiannapolis and water resources in Ontario? If this is the case, what then is the best environmental pattern of curtailment?" As pointed out in the best case analysis this type of question cannot be answered completely given our current level of understanding of acid rain and long range transport processes.

The most popular instance of these processes is the apparent prevailing drift from the midwest industrial belt over New York State and Canada. From the probable case impacts estimated in Section B3, an estimate of the contribution of curtailment alternatives to this situation in the midwest may be derived. Table 18 presents projected ambient increments under a do-nothing alternative (unconstrained case in Table 18) for all of the midwest cities included in this study. These results, which are based on a rather extreme high demand 1990 scenario, show that there are no midwest cities in which curtailment contributes as much as a 1 microgram per cubic meter increment to the 24 hour average annual sulfur oxide concentration. Results for the other curtailment alternatives studied fall in this same order of magnitude. Thus, the contribution of all of the curtailment alternatives to acid rain and long range transport problems appears to be, on average, small and fairly evenly distributed.

These average results over the winter season are important, but it is also important in the case of acid rain to consider shorter episodes of greater intensity. The impact of air pollution levels on health is a major concern in this type of programmatic study. Our growing understanding of health effects in recent years has turned attention away from peak levels of pollution toward average or minimum levels of exposure which seem to be more important to long-term dose-response relationships. The damage done by acid rain, however, may be represented by a much sharper threshold type of relationship. It is possible that short, intense pollution episodes can produce acid rain of higher than average pH. Such a situation can be produced by severe concentrated shortages under any curtailment alternative. The heavy curtailments in the midwest during the winter of 76-77 may be an example of this type of episode. As in that case, however, emergency reallocation of gas to relieve the economic disruption accompanying such curtailments provides a measure to abate the build-up of additional pollutants.

Part 4: Other Environmental, Health and Safety Issues

A. Other Pollutants

The combustion of alternate fuels generates water pollutants and solid wastes, whereas natural gas combustion is virtually free of these residuals. Emission coefficients for

water pollutants and solid wastes were plugged into the model developed for the air quality analysis to generate estimates of the quantities of these pollutants involved. Results for the do-nothing option evaluated for the base case 1-in-10 demand in 1981 are given in Table 22.

Because the same "multipliers" are applied to these pollution coefficients as to the air pollution coefficients, results for the alternate policy options would assume exactly the same patterns.

Beyond this simple quantification of the approximate order of magnitude of these residuals, there is no more meaningful assessment that can be made of the impact of these pollutants. Their ultimate impact will depend entirely upon where and how they are disposed. The trace quantities of complex organic compounds and heavy metals contained in the wastes are potentially toxic and hazardous substances, but the actual impact depends on the method of their disposal. The chain of causation which produces the final impact is many steps removed from federal curtailment policy. The regional patterns of generation of these wastes will vary marginally from one policy alternative to another by about the same degree as that exhibited in the air quality impacts. However, it is conceivable that, depending on methods of treatment and disposal, a small amount of waste in one region could cause more ultimate damage than a larger amount of waste in another region.

B. Resource Extraction, Transport, and Storage

Alternate fuels must be supplied to alternate fuel users. This entails environmental impacts due to the extraction, transport, and storage of these resources. The incremental impacts of these activities will be widely dispersed over many locations. The degree of additional impact is entirely a matter of how each of these activities are carried out at each of the locations involved. All of these activities are the subject of various forms of environmental regulation and compliance with these controls seems the only reasonable assumption. To at least put the problem into some perspective, it is meaningful to quantify the additional fuel supplies required. The do-nothing alternative (1981) would require approximately 2 million tons/yr of coal, 16 million bbls/yr. of distillate oil, and 11 million bbls/yr. of residual fuel oil. These estimates are probably much higher than the actual levels of alternate fuel use induced by gas curtailments because the very conservative dirty alternative fuel choice and 1-in-10 weather probability assumptions used for the air quality analysis were also applied in generating these numbers. Alternate policies produce similar quantities.

TABLE 22

TOTAL WATER POLLUTANTS AND SOLID WASTES GENERATED BY ALTERNATE FUEL COMBUSTION DUE TO CURTAILMENT IN 54 AQCR'S FOR THE DO-NOTHING ALTERNATIVE

Pollutant	Quantity (tons)
Solid Waste	1.96×10^6
BOD	143
COD	12,718
Total Suspended Solids	531
Total Dissolved Solids	42,580
Nitrates	69
Phosphates	47

C. Occupational Safety and Health

The handling, storage, and burning of alternate fuels introduces new sources of accident and exposure into the workplace environment. Again, this is the type of impact (equivalent in magnitude for all alternate policies) that will or will not occur depending upon the precautions taken and/or regulations covering each individual situation. No meaningful programmatic assessment can be made.

VI. AFFECTED ENVIRONMENT

The obvious questions that must be addressed in defining the environments affected by curtailment are:

- Where does curtailment take place?
- Where are curtailments the largest?
- Which areas are likely to receive the greatest air quality impacts due to curtailment?
- What is the existing ambient air quality in the affected areas and what would future air quality in these areas be like given different levels of curtailment?

These questions are taken up in this order in this chapter.

It seems likely that many of the places most dependent on gas would be the same places most susceptable to curtailment. Data on state industrial gas use as a percent of the national total is compared from two different sources in Figures 7 and 8. There is good agreement between the two sets of data. These percentages tend to focus attention on the gas producing states, the Great Plains, the Midwest-Northeast industrial belt, the South, and the Pacific Coast.

Figures 9 and 10 show the actual quantities of gas curtailed in the industrial and utility sectors during the winter of 1976-77. The industrial curtailments draw more attention to the East Coast. The utility curtailments are of outstanding note in California, the producing states, the Great Plains, and the South.

Figures 11 and 12 exhibit two different but related indicators of the potential severity of curtailments in terms of the extra emissions. Deep industrial curtailments will not necessarily mean severe ambient impacts if gas use is a very small part of the total fuel combustion in an area. These figures show few clear patterns anywhere, based on these considerations.

Figure 7. - State Manufacturing Gas Use as % of National Manufacturing Gas Use

based on 1976 census of large manufacturers. Sample accounts for 77% of all gas use in manufacturing.
0= less than 1%

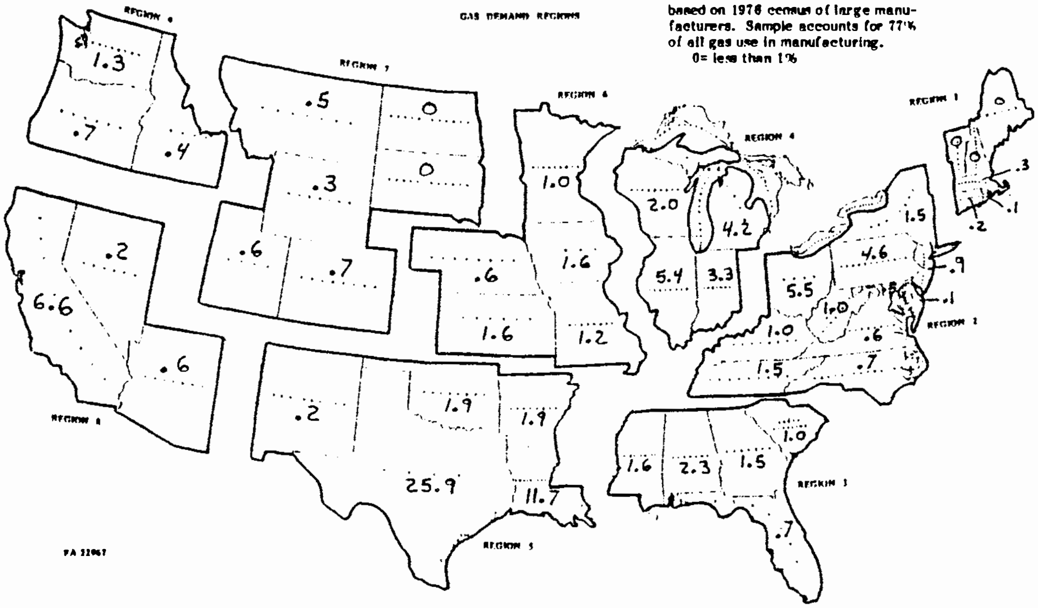

Figure 3. - State Industrial Gas Requirements As % of National Industrial Gas Requirements Nov.-March 1976-1977

based on Foster G101
ϕ = less than .1%

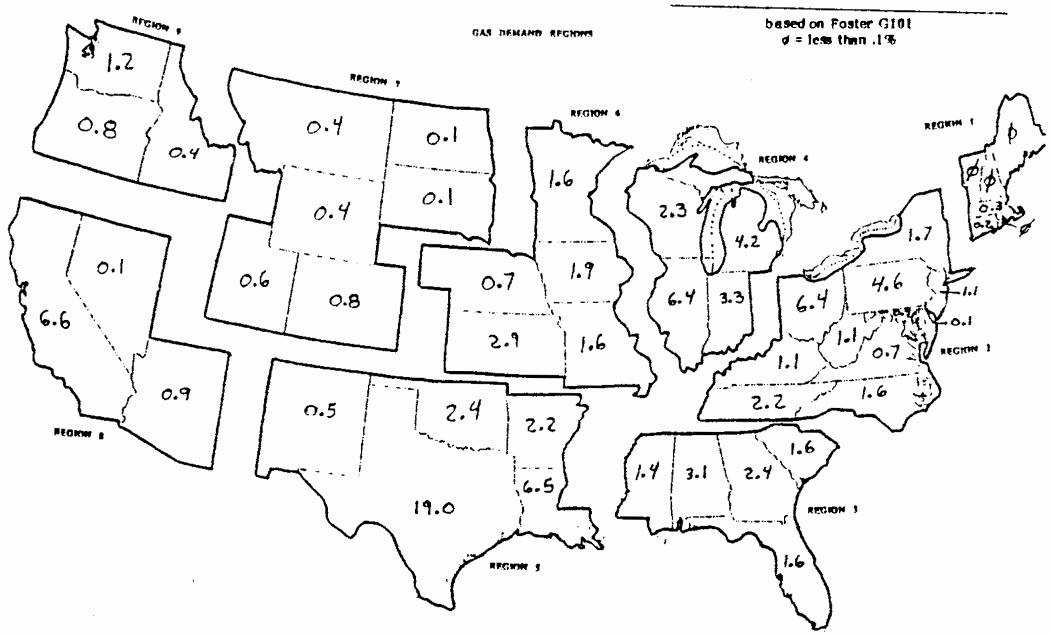

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Figure 9. - Industrial Curtailments (10^6 Mcf)
Nov.-March 1976-1977

based on Foster G101

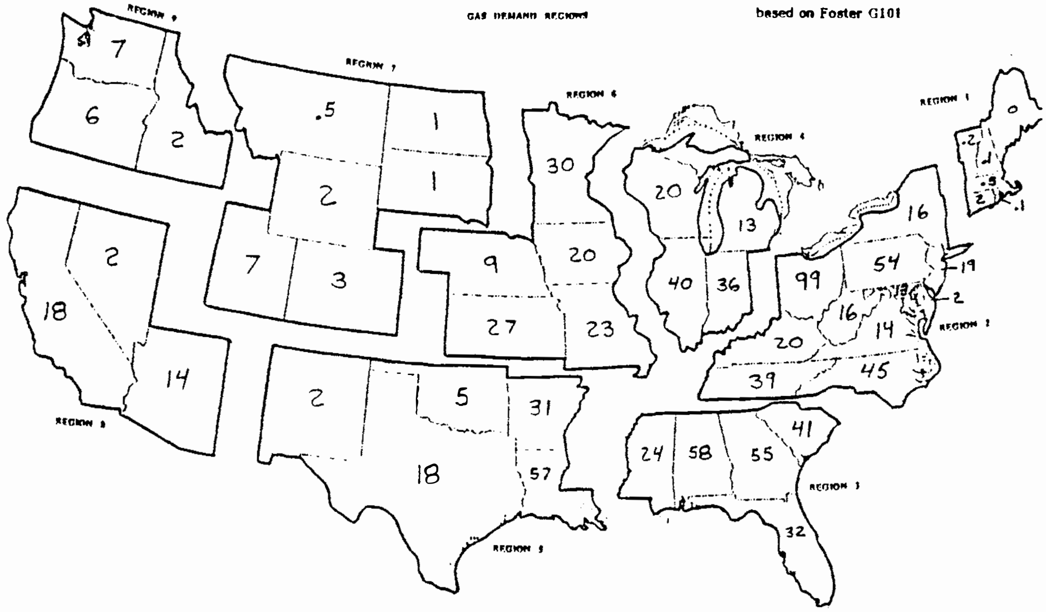


Figure 10. - Utility Curtailments (10^6 Mcf)
Nov.-March 1976-1977

based on Foster G101
ø = no utility gas use

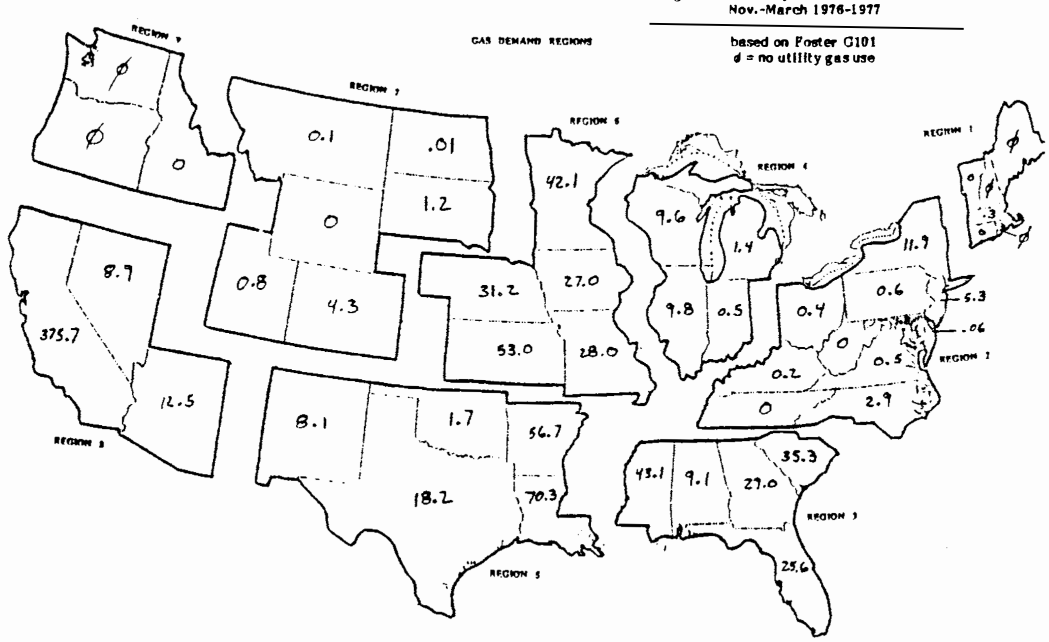


Figure 11. - Depth of Industrial Curtailments (%)
Nov.-March 1976-1977

based on Foster G10:

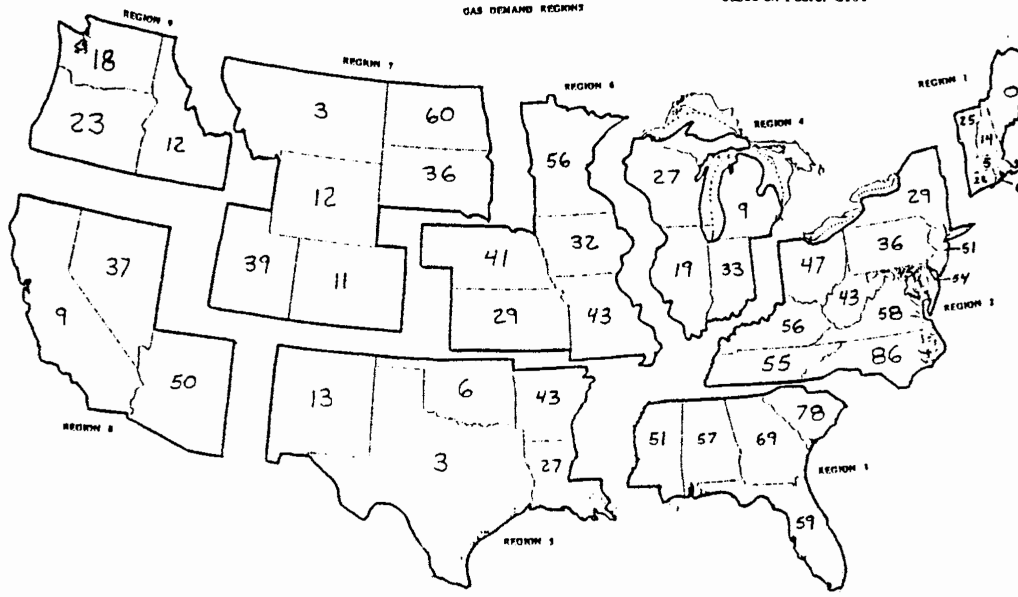
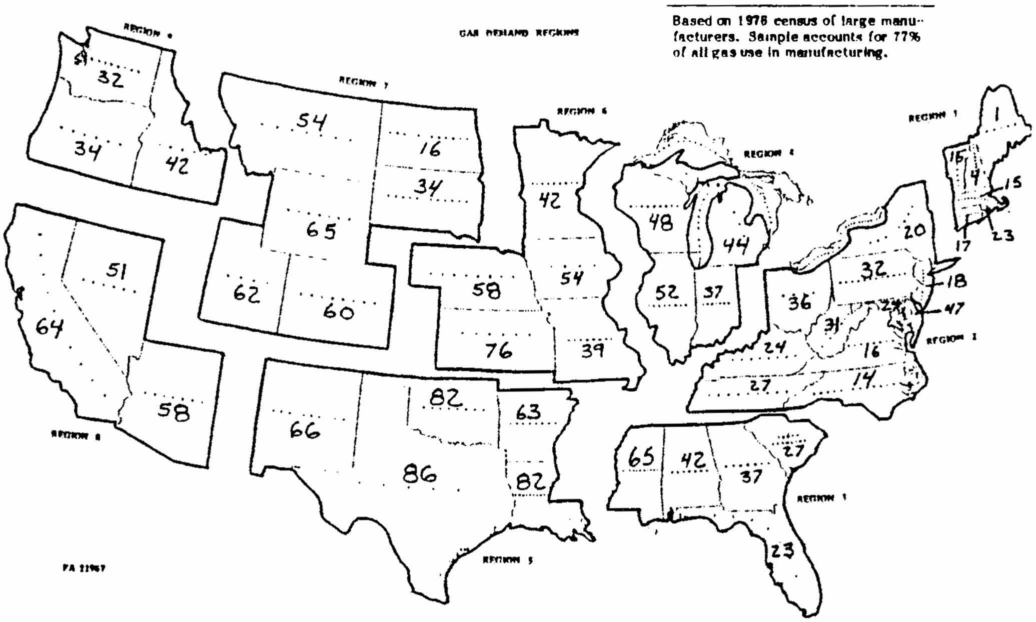


Figure 12. - Gas As % of State Manufacturing Energy Consumption

Based on 1976 census of large manufacturers. Sample accounts for 77% of all gas use in manufacturing.



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Data in Figures 13 and 14 show the incidence of permanent fuel switching and stand-by fuel use. The patterns in these data seem to align with the distribution of gas use and existing patterns of curtailment throughout the country.

As detailed in Sections V and VII, the 54 AQCR's selected for detailed analysis were chosen to reflect a mix of all of the characteristics displayed in Figures 10 through 15. The existing ambient air quality and the projected future ambients for these AQCR's were estimated by the procedures described in Section VII. The results are presented in Table 23. There is a predominant trend in these projected future ambients. They show improvement or no change in air quality in many industrialized areas of the midwest, south, and northeast while ambient levels actually increase in many parts of the producing states. These negative trends in the producing states are produced by SEAS model [6] assumptions regarding recent Federal intiatives to increase coal use and relax dependence on oil and gas.

Figure 13. - Permanent Fuel Conversions From Natural Gas to Alternate Fuels: States as % of National, 1973 to 1978

based on EIA survey

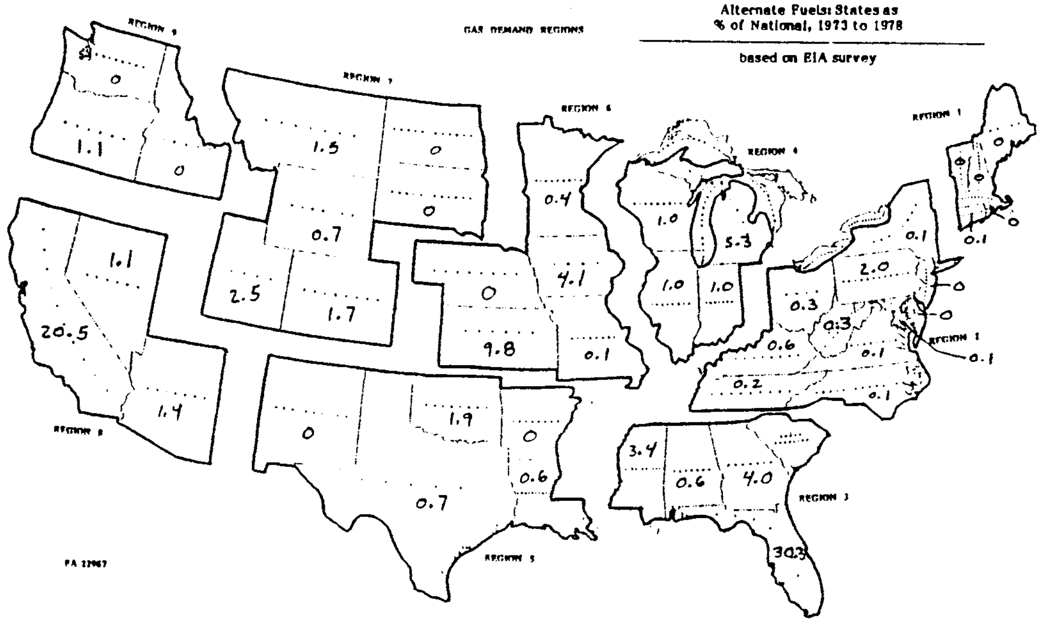


Figure 14. - "Reported" State Alternate Fuel Substitutions As % of Total National Fuel Substitutions to Offset Natural Gas Curtailments During Winter of 1976-1977

based on G101
ø = no alt. fuel substitution
o = less than .1%

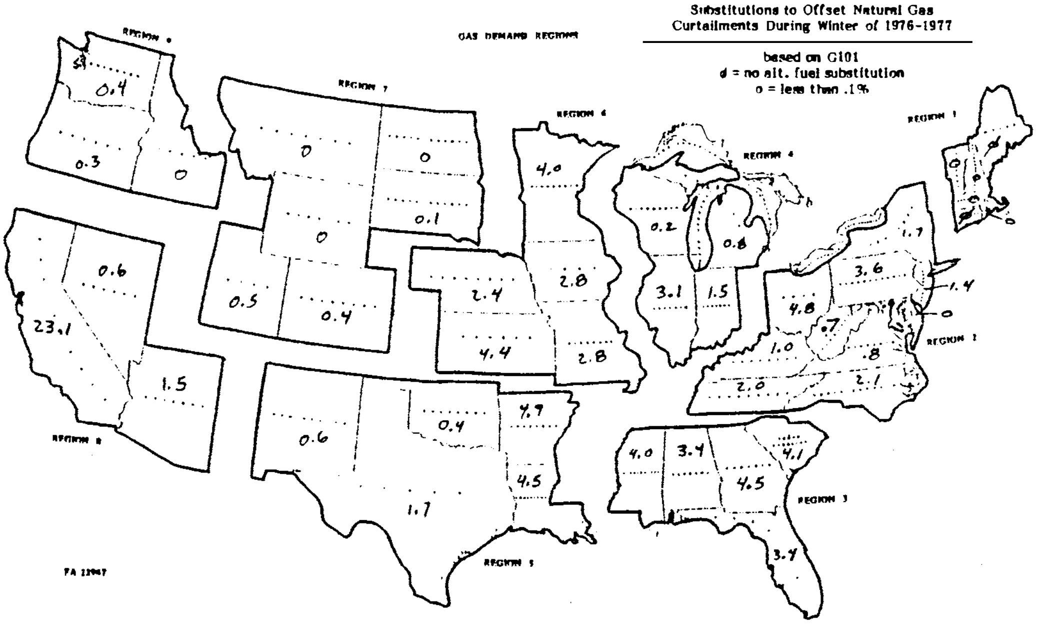


TABLE 23 - EXISTING AND PROJECTED 24 HOUR ANNUAL AVERAGE AMBIENT POLLUTANT CONCENTRATIONS FOR 54 AQCR's (ug/m^3)

		PARTICULATES			SULFUR OXIDES		
	AQCR	1976	1981	1990	1976	1981	1990
004	Birmingham, Ala.	86	57	23	6	6	6
005	Mobile-Pensacola	57	54	51	9	10	11
007	Florence, Ala.	51	32	9	7	4	3
016	Little Rock, Ark.	56	62	79	4	10	21
018	Memphis, Tenn.	66	75	87	23	26	30
019	Monroe, La.	52	81	116	3	9	21
024	Los Angelex, Ca.	99	97	93	11	13	14
030	San Francisco, Ca.	58	56	53	8	9	10
031	Stockton, Ca.	111	115	116	3	3	3
036	Denver, Co.	87	77	72	10	10	13
038	Pueblo, Co.	99	73	42	15	16	22
043	New York, N.Y.	53	56	57	21	22	22
045	Philadelphia, Pa.	74	66	57	29	25	20
053	Augusta, Ga.	45	45	48	6	6	9
055	Chattanooga, Tenn.	55	53	56	17	15	15
056	Atlanta, Ga.	47	59	81	14	18	24
067	Chicago, Ill.	76	58	39	24	22	20
069	Quad Cities, Iowa	76	58	32	10	9	8
070	St. Louis, Mo.	90	77	65	34	32	29
078	Louisville, Ky.	69	52	32	34	30	27
079	Cincinnati, Ohio	65	50	34	22	17	14
080	Indianapolis, Ind.	72	69	59	30	24	17
088	Cedar Rapids, Iowa	83	72	52	12	13	13
094	Kansas City, Kan.	82	77	75	7	7	9
099	Wichita, Kan.	56	66	72	4	5	5
103	Huntington, W.Va.	73	57	26	18	18	18
106	Baton Rouge, La.	55	74	108	3	6	12
115	Baltimore, Md.	69	55	35	24	25	26

(continued)

TABLE 23 (continued)

	AQCR	PARTICULATES 1976	PARTICULATES 1981	PARTICULATES 1990	SULFUR OXIDES 1976	SULFUR OXIDES 1981	SULFUR OXIDES 1990
122	Grand Rapids, Mich.	49	42	31	12	9	6
123	Detroit, Mich.	67	64	58	20	18	17
124	Toledo, Ohio	67	54	35	33	26	18
125	Kalamazoo, Mich.	52	62	67	11	11	10
131	Minneapolis, Minn.	65	73	76	16	12	8
153	El Paso, Tex.	91	102	107	18	18	19
162	Buffalo, N.Y.	59	50	40	40	27	27
173	Dayton, Ohio	66	50	33	20	20	19
174	Cleveland, Ohio	70	55	34	44	33	22
176	Columbus, Ohio	70	56	39	24	13	2
177	Lima, Ohio	63	48	28	15	17	18
178	Youngstown, Ohio	89	63	32	46	37	30
181	Steubenville, Ohio	101	86	49	93	73	49
186	Tulsa, Okla.	55	67	86	4	10	19
193	Portland, Ore.	48	49	56	19	36	57
197	Pittsburgh, Pa.	93	68	45	43	42	40
208	Nashville, Tenn.	62	39	11	12	9	7
214	Corpus Christi, Tex.	63	87	136	4	7	12
215	Dallas-Ft.Worth, Tex.	55	68	88	3	15	42
216	Houston, Tex.	68	73	90	5	8	15
218	Odessa, Tex.	69	81	86	3	5	10
220	Salt Lake City, Utah	79	72	58	20	20	26
229	Seattle, Wash.	49	56	62	17	17	17
234	Charleston, W.Va.	77	69	53	49	42	35
237	Appleton-Oshkosh, Wisc.	56	59	58	21	20	19
239	Milwaukee, Wisc.	64	66	66	7	7	8

VII. ENVIRONMENTAL CONSEQUENCES

Part 1: Basis for Economic/Regulatory Analysis

The background data and methods of analysis for the economic/regulatory analysis are described in detail in the accompanying Volumes 1, 2, and 4 of this study report. Following the new guidance from CEQ this material is not duplicated here in the environmental impact statement as all four volumes are being circulated together.

Part 2: Basis for Air Quality Analysis

A. Approach

In a programmatic study, it is natural to analyze aggregate quantities. For example, the accompanying economic/regulatory analysis compares alternatives on the basis of the total social costs of alternate curtailment policies. Three types of costs are identified:

- users' costs in dealing with shortages;
- suppliers' costs in minimizing shortages and shortage effects; and
- non-users' pollution costs

The concept of non-user pollution costs refers to the environmental impacts (largely air quality impacts) examined in this EIS. This concept is useful in describing the approach that was taken to the environmental analysis and is employed in the discussion in this section. It is also a useful illustration to contrast the different approaches taken to the economic and environmental analyses.

In the economic/regulatory analysis, an aggregate national-level comparison of users' and suppliers' costs under each policy alternative is made possible by the fact that the dollar is a very foregiving unit of measure in the following sense: a dollar's worth of curtailment cost has an equivalent value in Ohio or California, on pipeline A or pipeline B, to user A or user B, and to supplier A or supplier B. Further, for any two users or two suppliers facing the same circumstances (all other things held equal) the dollar cost per Mcf curtailed should be the same (i.e., have the same probability distribution). Given these relationships, the economic/regulatory analysis can proceed as a straight-

forward search for curtailment policies that produce lower total costs. The problem can be studied by a sampling approach -- examining prototype pipelines which are examples of the major types of curtailment systems, end-use profiles, and supply conditions. Moreover, detailed study of the variability between pipelines, users, and suppliers can be achieved by simulation and modelling of these prototype systems.

By contrast, the non-user pollution costs are more variable and more difficult to measure. The major type of non-user pollution cost involved is that associated with the air pollutant emissions produced by alternate fuels burned in place of curtailed natural gas. The distribution of these pollution costs is determined by an important additional dimension of variation which consists of a number of local site-specific characteristics. This is apparent in consideration of an expression for the pollution cost such as the following:

$$\text{Pollution Costs} = \begin{array}{c}\text{Sensitivity to}\\ \text{Incremental Impacts}\end{array} \times \begin{array}{c}\text{Susceptability to}\\ \text{Bad Air Conditions}\end{array} \times \begin{array}{c}\text{Emissions}\\ \text{Per Mcf}\\ \text{Curtailed}\end{array}$$

$$(\$/\text{Mcf}) = (\$/\text{ug/m}^3) \times (\text{ug/m}^3/\text{ton}) \times (\text{tons/Mcf})$$

The "sensitivity to incremental impacts" ($\$/ug/m^3$) "variable" represents a combination of a damage function and an assumption about the value of the damages incurred. The most important and most studied of such relationships is that between air pollution and health effects. The value of this "variable" will be different from one location to the next depending upon such factors as whether the extra pollution from curtailed users causes exceedence of the ambient standards (the official levels designated to protect health) and the number of people exposed to such levels.

Further complicating matters, atmospheric dispersion processes (the $ug/m^3/ton$ variable) vary tremendously between different locations and between different points in time at the same location. Thus, there is no fixed relationship between the ambient concentration (ug/m^3) and the amount of additional pollution (tons) generated by curtailments. Finally, there are a myriad of local factors (pollution regulations, industrial mix, and fuel supplies, etc.) that can combine to produce widely varying relationships between the amount of gas curtailed and the quantity of emissions produced (tons/Mcf).

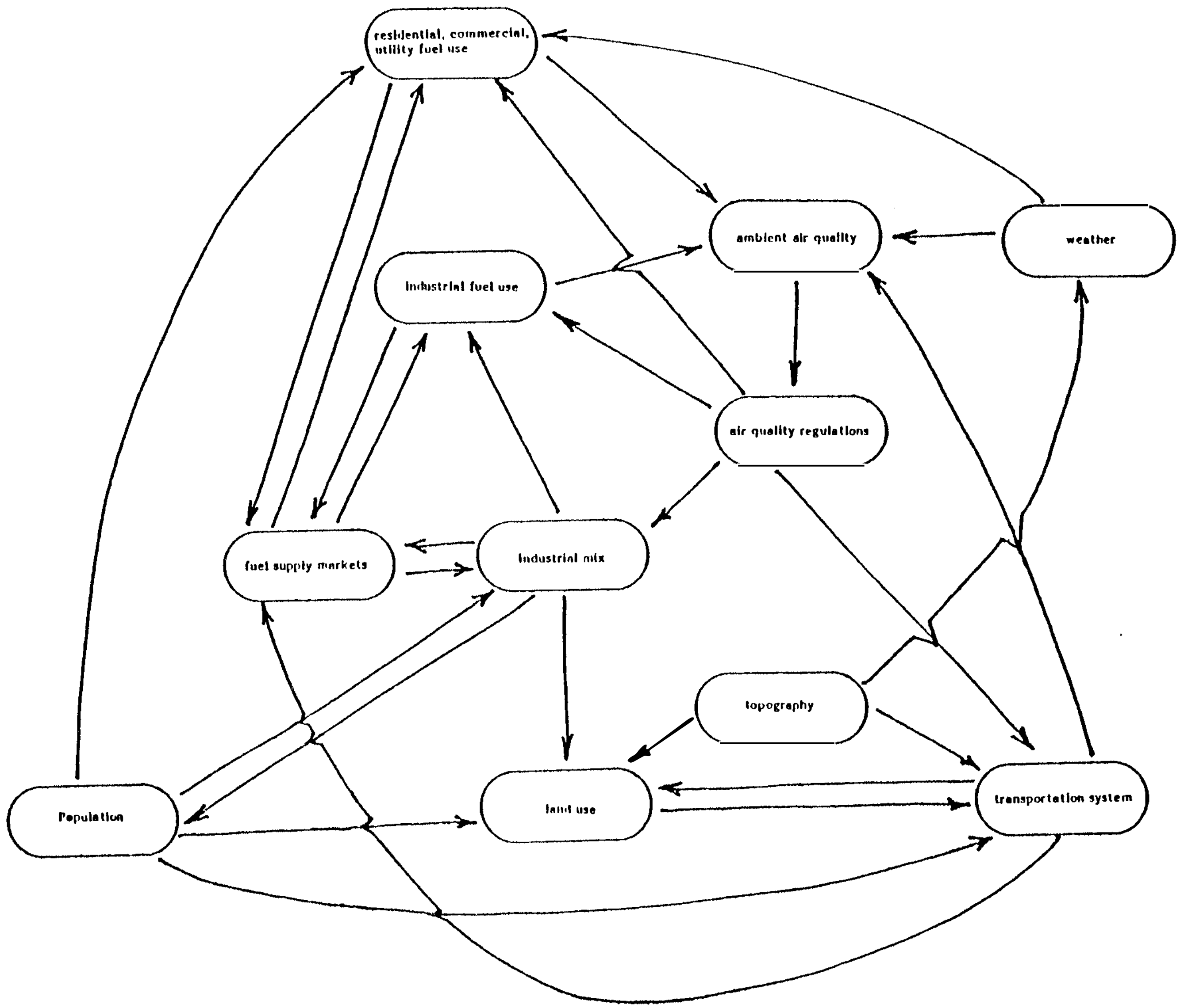
Thus, the right-hand side of the pollution cost expression, above, displays three aspects of site-specific variability which must be accounted for in the air quality analysis in order to reduce the problem to one of the same type as the economic/regulatory analysis (i.e., the left-hand side of the expression). Once this reduction in variety is achieved, the problem can be approached in the same manner of searching for gas curtailment strategies that are more efficient and equitable; but, in this case, in terms of the pollution cost criteria.

Because the non-user pollution costs exhibit these extra dimensions of site-specific variation, the sample of prototype pipelines selected for evaluation of users' and suppliers' costs in the economic/regulatory analysis is not necessarily adequate for the pollution cost analysis. The values of the three key variables in the pollution cost expression are determined by the local influences identified in Figure 15. This figure illustrates as well the complex interrelationships between these factors. The sample cases selected for the pollution cost analysis must take account of these sources of variability. The choice of such a sample is further complicated by the fact that locations having different pollution impact characteristics are served by various combinations of pipelines that have individual supply, demand, and curtailment characteristics. Therefore, a sample of locations that are representative of the factors affecting pollution costs may be connected to a collection of pipelines that are not representative of curtailment systems.

Fortunately, preliminary analysis of the scope of the curtailment problem permits some useful partitioning of the universe from which a sample is to be drawn. As described in more detail in Sections V and VI, over 80% of total curtailments and total alternate fuel substitutions take place in the more heavily industrialized regions of the country. Further, most industrial gas use, the primary target of curtailment, is concentrated in the major U.S. urban areas. U.S. Census data from the 1976 Annual Survey of Manufacturers [1] shows that 68% of industrial gas use takes place in 188 Standard Metropolitan Statistical Areas (SMSA's). The remaining 32% of industrial gas use takes place in non-metropolitan areas.

These 188 SMSA's were further partitioned into large and small gas consuming SMSA's using a criterion of 10 Bcf/yr. The large gas consuming SMSA's, many of which are adjacent, were combined into their EPA-designated Air Quality Control Regions (AQCR's) — the units for which air quality data are available. Several smaller gas

Figure 15. Site Dependent Variables Affecting Potential Ambient Impact



consuming SMSA's were included with the larger ones when they fell within the same AQCR. Proceeding in this manner, it was found that a group of 54 AQCR's, containing 100 SMSA's, could be singled out which account for 61% of total U.S. industrial gas use.

The above process produced three categories of industrial gas use:

(1) large gas-consuming cities (54 AQCR's comprised of 100 SMSA's, accounting for 61% of total industrial gas use),
(2) small gas-consuming cities (88 SMSA's accounting for 7% of total industrial gas use),
(3) non-metropolitan areas (accounting for 32% of total industrial gas use).

Table 24 presents these three geographic categories of industrial gas use and ranks them according to certain key determinants of the variables on which the non-user pollution cost calculation is based. These judgemental rankings were a basis for hypotheses that were posited to assist in sample selection. More fully articulated, these hypotheses may be stated as follows:

- The larger gas consuming cities (54 AQCR's) present the greatest potential for impacts of national-level importance due to the large quantities of gas that may be curtailed; and the high degree of substitution capability in the presence of higher existing pollution levels, to which large numbers of people are exposed.

- The smaller gas consuming cities (88 SMSA's) present a lesser potential for impacts of national-level importance due to the smaller quantity of gas available for curtailment and, in many cases, a smaller population exposed. Some exceptions to this rule would be expected in cases where gas is the predominant fuel.

- The least potential for impacts of national-level importance might be expected in the non-metropolitan areas where emission sources may be more scattered and removed from large populations and alternate fuel supplies. Some exceptions to this rule would also be expected.

TABLE 24. - COMPARISON OF FACTORS DETERMINING AMBIENT IMPACT FOR THREE GEOGRAPHIC CATEGORIES

Variable	Area / Determining Factors	54 Large Gas Consuming AQCR's	88 Small Gas Consuming SMSA's	Non Metropolitan Areas
$\$/ug/m^3$	high existing pollution levels	1	2	3
	large population	1	2	3
$ug/m^3/ton$	concentrated land use	1	2	3
	Gas a high % of total fuel use	2	2	1
tons/mcf	less strict emission limits	2	2	1
	more likely to substitute	1	1	2
mcf	% of total Industrial Demand	61%	7%	32%

Rankings:

1 = highest value of determining factors
2 = lowest value of determining factors

note: higher ranking indicates higher pollution cost

In formulating these hypotheses it was reasoned that in order for one curtailment policy to be signifcantly better or worse than another at a national level, in terms of an environmental criterion, there would probably have to be important impacts at several points in the system, the amerlioration of which require reallocation of a significant quantity of gas or a significantly different pattern of gas deliveries. If the impacts of a policy are of only minor concern or require only a minor reallocation of gas, they may be dealt with as special cases not necessitating a major change in the curtailment policy.

On the basis of these hypotheses, it was determined that the 54 large gas-consuming AQCR's were the most important subjects for study - - offering the greatest possibility of finding significant impacts that involve significant quantities of gas. Rather than entertain the further problem of developing a sampling approach to this segment of the universe, it was determined that the acquisition of data for all 54 AQCR's was a manageable -- though large -- task. This approach also circumvents the problem of selecting sample pipelines. By taking all 54 AQCR's, the associated sample of the pipeline system automatically represents at least the same 61% of industrial gas use and most of the major industrial nodes on the delivery network.

The distribution of the 54 AQCR's across the country and throughout the pipeline system also gives assurance that regional differences are taken into account. As an aside, it is noted that several cities served by intra-state gas systems are included among the 54 AQCR's despite the fact that the actual study focus is the interstate pipeline system. These AQCR's are included to assure that the search for best environmental alternatives is complete and unconstrained.

To study the impacts of curtailment in 54 AQCR's - - essentially 54 case studies - - a very large quantity of data was required. Data on emissions, ambient pollutant concentrations, and many other local factors were derived from multiple sources as described in sections VII.B and VII.C, below.

Data of similar detail, quality, and extent were not available to support an equivalent analysis of the smaller gas-consuming SMSA's and non-metropolitan areas. Data for some important parameters are not reported at this level of disaggregation. In some cases plant-specific data would be required which is an inappropirate level of study for

programmatic analysis. It was nonetheless recognized that impacts in these areas may be locally important in certain cases, especially where gas is the predominant fuel. Available data did permit a limited analysis of the extent to which gas is the predominant fuel in the small gas-consuming SMSA's. Results of this analysis are presented in Section V. It is concluded that any extreme instances of localized impact that may arise may be treated as special cases. It is expected that such special case treatment would not require large enough quantities of gas to affect the national-level comparisons of alternative curtailment systems.

The data for the 54 large gas consuming AQCR's were used to develop a model for analysis of alternate curtailment policies. In general, this model consists of 54 sets of data used to estimate the three key variables that determine the non-user pollution cost ($\$/ug/m^3$, $ug/m^3/ton$, tons/Mcf) and a set of input assumptions about how pipeline curtailment systems work to allocate the other key factor — the Mcf's of curtailment. The major components of the model are diagrammed in Figure 16.

In this figure, the three rectangles represent modules for the calculation of the three key variables from data sets for each individual AQCR. The two outside loops in the figure represent the two "outside loops" in the model. That is to say that the enclosed three modules are run for each AQCR (1st loop) on each pipeline (2nd loop).

The wavy-lined shapes in the figure indicate that the enclosed quantity is an input to a module. As shown, the inner modules are inputs to the outer modules. Another type of input to the modules is designated by a diamond shape. These inputs are policy-sensitive assumptions about demand, curtailment, and substitution that can be adjusted in one or both of the outside loops to simulate the effects of different curtailment policies.

The model thus summarized in Figure 16 can calculate and compare the non-user pollution costs associated with any curtailment alternative; and, with specification of constraints, can be used to search for curtailment strategies that offer the least costs. However, as evident in Section V, results of the model analyses are not presented in terms of the idealized \$/Mcf pollution cost to be calculated by the outermost module in Figure 16. This pollution cost concept has been carried in this discussion largely as an aid in describing the approach taken and the resulting model. Quanitification of this

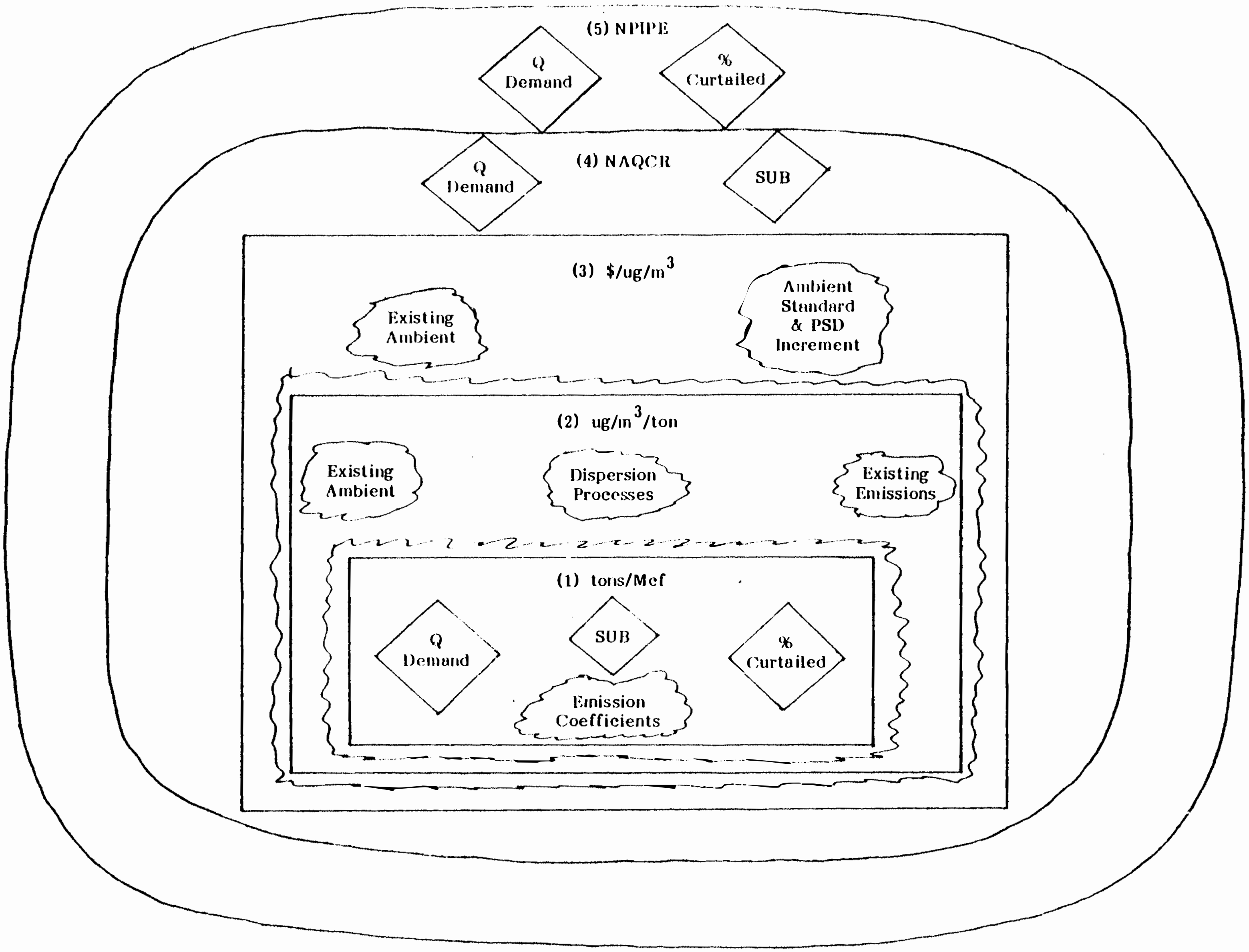


Figure 16. Design of Computer Model for Environmental Analysis

pollution cost concept was a part of the original research plan. It was thought that alternate curtailment policies might present some complex trade-offs between economic and environmental objectives. Despite the difficulty of valuing pollution costs, such a measure can help to make the evaluation of such trade-offs a very explicit procedure in which the necessary value judgements are plainly visible.

For this endeavor, Dr. Lester B. Lave was recruited as a consultant to the study team. Dr. Lave is one of the foremost researchers in this particular field. The outcome of model analyses, however, indicated that all alternatives displayed ambient impact potential in the same order of magnitude which was a very small increment in most cases. The net impact of one alternative versus another (or versus the do-nothing alternative) was less than 1 ug/m^3 in very nearly all cases. It is noted that these cases were constructed with some very conservative assumptions such as 1-in-10 weather probability, 100% substitutability, and dirty alternate fuel bias. Thus, serious air quality trade-offs did not seem to be involved in these alternatives. The pollution cost calculation was not carried through as it would add little to the analysis, given these results.

The $\$/ug/m^3$ module of the model was, therefore, not used in evaluating the alternative curtailment policies in Section V.B. It was employed, however, in the best case analysis in Section V.D. There, this module was used as a set of constraints to simulate EPA non-attainment and prevention of significant deterioration policies. The non-attainment constraint represents the implicit judgement that extra pollution increments in AQCR's above the EPA standards have an infinitely large cost and are therefore not permitted. The prevention of significant deterioration constraint is based on the assumption that an extra pollution increment in AQCR's below the EPA standard has the same cost in all such places.

Part B, below, reviews the sources of the estimates of site-specific parameters for the 54 AQCR's which form the data base for the two inner-most modules of the model shown in Figure 16. Part C describes the assumptions that were applied to the outer loops to simulate alternative policies. Before coming to these sections, however, it is important to discuss one other major set of considerations pertaining to the modelling approach: the selection of a model of ambient dispersion processes for use in the second module ($ug/m^3/ton$) of Figure 16.

As explained in the above discussion of the approach to selecting sample AQCR's, air quality is an extremely local phenomenon. The sample AQCR's were selected to represent local differences in the key variables that affect the amount of pollution likely to result from curtailment. These may be thought of as "structural" differences between the AQCR's relating to such things as differences in the industrial mix, differences in local fuel supply markets, differences in background emissions and dispersion patterns, and the other factors shown in Figure 15.

The approach taken to developing the input data for the model was to try to find the best estimates of the average winter season values of these key structural variables in the 54 AQCR's. In this way, the model output is certain to display the effect of these structural differences in the comparison of alternatives and in the development of best and worst cases. Such data was developed for all 54 AQCR's to satisfy input requirements of the proportional rollback ambient model. The equation and associated inputs are shown in Figure 17.

As discussed in some detail in Section V, the simple proportional rollback model is not regarded as the most precise estimator of ambient impact. It is better to think of it as an indicator of the "pollution potential." It is, however, a very appropriate indicator for the type of relative comparisons of alternatives that are the object of these investigations. The impacts calculated from the input quantities shown in Figure 17 give a good indication of how the "structural" differences between AQCR's will produce different susceptiabilities to ambient impact from curtailment. This is due to the fact that the variation between sites is embodied in the inputs to the rollback equation. This feature is displayed in Figure 18 which cross-tabulates the components of site variability from Figure 15 with the inputs to the rollback equation from Figure 17.

SECOND MODULE

$$NA = (EA)\ \frac{NE}{EE}$$

New Ambient
results presented
in Section V

Existing Ambient
for each AQCR
by pollutant

Existing Emissions
for each AQCR
by consuming sector
by pollutant

FIRST MODULE

New Emissions

$$\left(\begin{matrix}\text{Gas}\\ \text{Demand}\end{matrix}\right) \left(\begin{matrix}\%\\ \text{Curtailed}\end{matrix}\right) \left(\begin{matrix}\%\\ \text{Substitutability}\end{matrix}\right) \left(\begin{matrix}\text{Alt. Fuel}\\ \text{Choice}\\ \text{Coefficients}\end{matrix}\right) \left(\begin{matrix}\text{Emission}\\ \text{Coefficients}\end{matrix}\right)$$

Gas Demand	% Curtailed	% Substitutability	Alt. Fuel Choice Coefficients	Emission Coefficients
for each AQCR by consuming sector	by sector by pipeline	by sector	by sector by fuel	for each AQCR by sector by fuel by pollutant

Figure 17. - Component Inputs to the Rollback Equation

Site Factors \ Rollback Components	Existing Ambient	Existing Emissions	Gas Demand	% Curtailed	Substitutability	Alternate Fuel Choice	Emission Coefficients
Population			*				
Residential, Commercial, Utility Fuel Use	*	*	*	*			
Industrial Fuel Use	*	*	*	*	*	*	*
Fuel Supply Markets			*	*	*	*	
Industrial Mix	*	*	*	*	*	*	*
Land Use	*						
Topography	*						
Transport System	*	*					
Ambient Air Quality	*						
Air Quality Regulations	*	*			*	*	*
Weather	*		*	*	*		

FIGURE 18
INCORPORATION OF FACTORS AFFECTING SITE VARIABILITY IN COMPONENT INPUTS TO THE ROLLBACK EQUATION

B. Basis for Parameter Estimates

1. Overview

The two inner most modules (tons/mcf and ug/m^3/ton) of the environmental model developed for evaluating alternate policies require, as input data, estimates of the parameters itemized in Figure 17. The basic data set with values for all 54 AQCR's contained about 3800 individual estimated values. In this basic data set, all estimates were developed on an annual basis.

As a part of the accompanying economic/regulatory analysis, high, low, and base case gas demand scenarios were developed. Details of the demand analyses are presented in Section VI.A and VI.D of Volume 4 of the study report. These scenarios were based (in the industrial sector) on different assumed rates of permanent fuel switching away from gas in the presence of incremental pricing. The environmental model was run with the basic annual data set and these permanent fuel switching assumptions along with alternate fuel choice coefficients for permanent switching. The model was used in this way to generate values of demand, emissions, and ambient adjusted for the various permanent switching assumptions. These adjusted values formed the basis for six data sets: high, low, and base case — each for 1981 and 1990. This procedure also provides, incidentally, the estimated impacts of different levels of permanent switching which can be partially caused by curtailment policies.

Seasonal adjustments of these annual data sets were then performed so that the model could be used for analysis of winter heating season curtailments. A second version of each seasonal data set was then developed to reflect the fact that the 54 AQCR's are served by a complex network of pipelines. These versions divide the 54 AQCR's up among 25 pipelines or intra-state systems according to formulas that roughly approximate the actual systems. These larger data sets each contain about 5500 entries.

Altogether some 40 to 50,000 estimated values were employed in the data sets used for analysis. These estimates were derived from several million individual pieces of data. This process unavoidably involves some error. Despite attempts to use the best available information, err on the side of overestimating the impact, and exercise care in what guesswork was required, a number of types of problems were consistently troublesome, including:

- disaggregating various data to the AQCR and end-use consumption level;

- reconciling different types of data not usually reported or used together (e.g. distribution companies and AQCR's); and

- projecting heterogeneous data sets to future benchmark years.

The potential error implicit in these facets of a programmatic study derived from secondary sources is too frequently left unmentioned. For all of these difficulties, it is nonetheless felt that the data is adequate to confirm the relative comparisons of alternate policies and the order of magnitude of the impact estimates presented in Section V. But the magnitude and complexity of this undertaking is an important basis for another conclusion of Section V — that it would be administratively awkward and difficult to adopt curtailment policies requiring continuous evaluation on the basis of air quality criteria at the programmatic level.

The basis for the estimates used in the data sets are reviewed in the remainder of this section, organized according to the major components shown in Figure 17.

2. Existing Ambient

The rollback equation requires as a key input an estimate of the existing average ambient concentration of pollutants in the 54 AQCR's. Here the intended meaning of "existing" is the level that prevails before the effect of curtailment is added in. Unfortunately, most all of these 54 AQCR's are presently affected by curtailment so there is some unavoidable double counting entailed in the use of "actual" existing data on ambient concentrations. This effect is somewhat cancelled out, however, by the fact that the focus of analysis is on the relative differences between policies.

Estimates of the average annual ambient (24 hour) concentrations of particulates and sulfur oxides in each AQCR were developed from EPA's published monitoring data for 1976 [7]. The monitoring stations (usually 20 to 50 of them) for each AQCR were located on a local map of the area). Those near the outer suburbs probably far removed from industrial sources, as evidenced by generally lower concentrations, were discarded. Of the remaining majority of the stations, many were often discarded on the basis of having too small a sample size (say fewer than 20 or 30 observations). The

remaining values were summarized in a simple arithmetic mean of the annual means for each station. This value was taken as the average existing ambient for the AQCR.

The annual mean values, calculated as above, were projected from this 1976 base to 1981 and 1990 via the rollback equation using AQCR emission projections for 1975, 1980 and 1990 taken from a run of the SEAS model (Strategic Environmental Assessment System) [6] that had scenario assumptions roughly comparable to the gas demand scenarios developed for this study [5]. These ambient projections for the 54 AQCR's are given in Table 23.

These ambient projections were then adjusted for the different scenarios by adding in the emissions increments resulting from the amount of permanent fuel switching assumed (not accounted for in the SEAS scenario). This operation was performed by the computer program.

Finally, these sets of ambient estimates were seasonally adjusted for the study of winter season curtailments. This adjustment was also made internally in the computer program. To develop the coefficients to be used, some limited research into seasonal variation was conducted. The frequency distributions and actual data for a small but widely scattered sample of monitoring stations in AQCR's was selected for study. These stations showed no significant seasonal variation in sulfur dioxide levels. Particulates, however, seemed to vary between the heating and non-heating seasons. In the stations examined, this variation was consistently close to the amount of the difference between the arithmetic and geometric means. This was used as a rule of thumb to adjust the winter season existing ambient levels of particulates slightly downward.

3. Existing Emissions

As noted in the ambient discussion above, emission projections and the 1975 base level emissions for the 54 AQCR's were taken from a run of the SEAS model [6]. These emission totals were provided for the AQCR as a whole and broken down into the contribution of each consuming sector. These values were then adjusted, internally in the computer program, to adjust for the additional emissions due to the scenario assumptions regarding permanent switching away from gas. Research into the seasonal patterns of emissions revealed that, with some exceptions, the industrial sector

emissions are fairly constant between winter and summer. For the residential and commercial sectors, however, it was found that most of the annual fuel consumption (and therefore emissions) take place in the winter. The percent of total fuel use in the winter season was found to be in the same range for both sectors in most parts of the country. Rules of thumb of 60% for the commercial sector and 70% for the residential sector were selected.

4. Gas Demand

Data on industrial gas demand was taken from the 1976 U.S. Census of Manufacturers [1]. This is survey data reported by SMSA's. Fortunately, the highly urban character of the 54 AQCR's under study results in their being comprised of one or more SMSA's. The more common approach is to disaggregate state-level data (such as EIS form 50, formerly G101) to AQCR's, which is much less precise. The census data is based on a 77% sample of manufacturers including a larger than normal proportion of small energy consumers. From this data source, it is also possible to derive an estimate of the percent of total industrial fuel use in an SMSA that is accounted for by gas — an important indicator of potential ambient impact.

An important next step is to subdivide these quantities of industrial demand into categories of end use: large boiler, small boiler, and process. Research into this question was complicated by the fact that there is a lot of difference of opinion on the definition of process gas use and there are few precise estimates. In addition, the large boiler/small boiler distinction used in collecting data on natural gas use (300 Mcf/day) is very different from that most used in differentiating emission control requirements (250 MMBtu/hr.). The approach taken to this step was to compare two independent estimates.

Two separate estimates were prepared, one working primarily with G101 [2] and MFBI [3] data, and the other working primarily with the SEAS model [6] data base. There seemed to be agreement between these two and other sources that process gas use might hover around 50% of industrial gas use. Estimates of the boiler categories differed a little more. The worst case estimate (in terms of emission potential) was selected which divides the boiler users into 15% large (greater than 250 MMBtu/hr.) and 85% small. These rules of thumb were used throughout except where the estimates indicated important differences between pipelines.

Demand in the utility sector was disaggregated from state-level data taken from the 1977 Inventory of Power Plants in the United States [12]. These estimates were checked against the characteristics of the utility sector on different pipelines, as indicated in the demand projections [5].

The residential and commercial gas demands were derived by applying the pipeline-level proportions of these sectors to industrial demand.

All of the above demand estimates were then projected to 1981 and 1990 using the growth rates (negative in the case of permanent switching) forecast for each consuming sector. [5].

In all of the above applications of the demand estimates, it was the case that the estimates were only made for the prototype pipelines studied in the economic/regulatory analysis. These estimates were extrapolated to the other pipelines involved in the air quality analysis by matching pipelines serving similar demand regions having similar characteristics. This approach follows from the thrust of the prototype or sample pipeline idea.

5. Percent Curtailed

The simulation modelling of curtailment on prototype pipelines performed for the economic/regulatory analysis provided the curtailment levels used in the air quality analysis. The average percent curtailment for the 1-in-10 winter season was used. As with the estimation of demand as described in the preceding section, this analysis requires extrapolating from the prototype pipelines to the 25 pipelines used in the air quality analysis. Here the prototype matching was done on a non-geographic basis of similarities in curtailment systems, end-use, and levels of shortfall. It is believed that this procedure provides ballpark estimates in the absence of better information. The greatest uncertainty here was with the estimates chosen for intra-state curtailments in the producing states. These are thought to be on the high side.

It is noted that the percent curtailments used are the average end use curtailments for the pipeline rather than pipeline percent shortfalls. This is because the simulation models account for storage capability.

The average percent curtailments given for the pipelines were in terms of curtailment priority categories. These had to be translated into end-use sectors for the air quality analysis. This was done on a pipeline-by-pipeline basis using all of the information available about each different curtailment system. Again, in the absence of better data on this subject, these estimates are thought to be reasonable. An effort was made in this process to err on the side of overstating industrial curtailments.

6. Substitution

There are two aspects of alternate fuel substitution important to the air quality analysis: permanent switching away from gas and temporary use of stand-by fuels during curtailment episodes. These topics are taken up in two subsections, below.

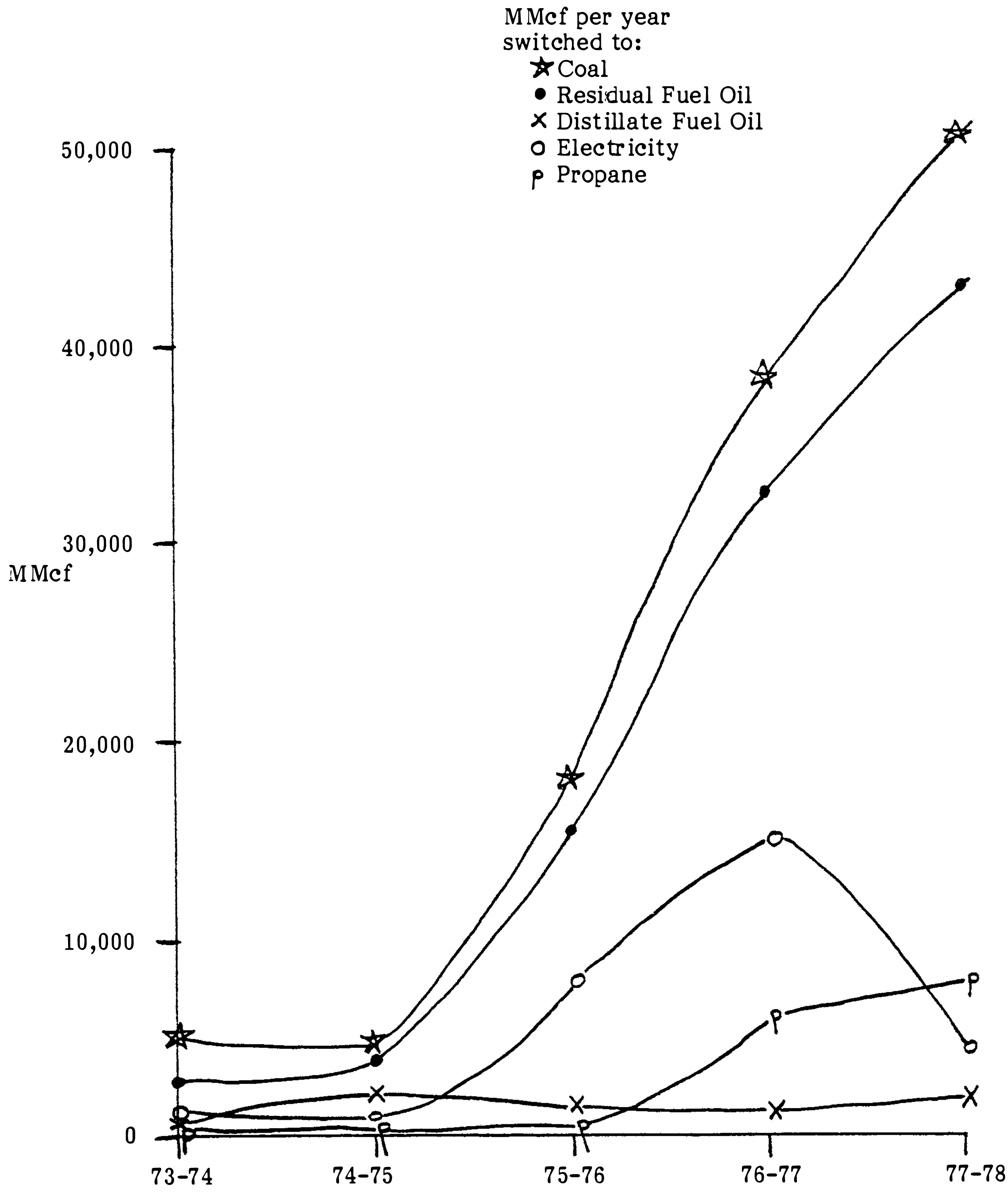
a. Permanent Switching

Much of the forecasting work done on fuel switching behavior is based on the idea that the prices of alternate fuels are a major factor entering the decision. This hypothesis is not, however, the sole basis for fuel choice decisions. Fuel switching is represented by a very complex decision function which involves, in addition to fuel prices, such items as: the capital cost of retrofit equipment (including pollution control gear @ up to 50% of the total), space in the plant for storage and handling, down time required for the switch, and the comparative costs and benefits of other options including energy conservation measures and measures to better cope with gas curtailments. This broader view of the decision function is supported by EPA's recent approval of the "bubble concept", greatly increasing the flexibility of industry in meeting emission standards.

The most recent data available on permanent switching is an EIA survey [3], the results of which are summarized in Figure 19. The indication from this figure is that permanent switching could be a serious air quality problem. The EIA study, however, was only a preliminary small sample analysis from which it is difficult to generalize.

For this study, the estimates of the maximum switching, likely under incremental pricing, were used as a basis for demand scenarios, so the permanent switching assumption is built in to the comparison of scenarios [5]. A major study conclusion regarding permanent switching (reflected in the analysis in Section V) is that it may be more sensitive to the effects of curtailment policy on user confidence than is commonly recognized.

Figure 19. - Annual Permanent Switching
For National Composite of All Sectors



b. Temporary Substitution

The principal sources of data on temporary or stand-by fuel substitution are the 1976 U.S. Census Survey of Manufacturers [13], the EIA form 50 (formerly G101 data) [2], and the Major Fuel Burning Installation (MFBI) study performed in 1977 [8]. All of these data were examined in detail in an effort to develop answers to the following questions:

- Substitutability — what percent of gas users in a given category have the capability to use stand-by fuels when they are curtailed?

- Fuel choice — of the gas users in a category having substitute fuel capability, what fuel do they use?

These two questions had to be answered for each consuming sector in each AQCR, at first, seeming an enormous task. Analysis of the data, however, revealed that the range of values was fairly stable across the country. Figure 20 presents estimates of substitutability in the industrial sector based on the U.S. Census data [13]. The G101 data [2] gave a similar range for substitutability. Interestingly, however, all of the sources of data available were taken prior to or during the extreme winter of 1976-77, thus not reflecting adjustments made as a result of the deepest curtailment experiences. Research undertaken as a part of the economic/regulatory analysis indicated that the degree of substitutability may have increased substantially from these levels. An assumption of 100% substitutability in all sectors was finally selected as representing the most additional emissions and therefore a worst case.

Figure 21 presents alternate fuel choice data from the U.S. Census 1976 survey [13]. This Census data is the most detailed source of this information and is based on the largest sample size (77% of industrial use), containing a larger than normal proportion of small gas users. Here, again the data are seen to fall into a relatively stable range. This same range was evident also in the G101 [2] and MFBI data [8]. As a simplifying assumption, a constant set of values at the extreme worst case end of this range was selected for use. This was then adjusted for different consuming sectors to reflect differing fuel preferences between sectors. The final assumptions are those given in Table 8 of Section V.

Figure 20. - % of State Manufacturing Gas Use Which is Substitutable

based 1976 census of large manufacturers sample accounts for 77% of all gas use in manufacturing.
ϕ = not reported, assumed small

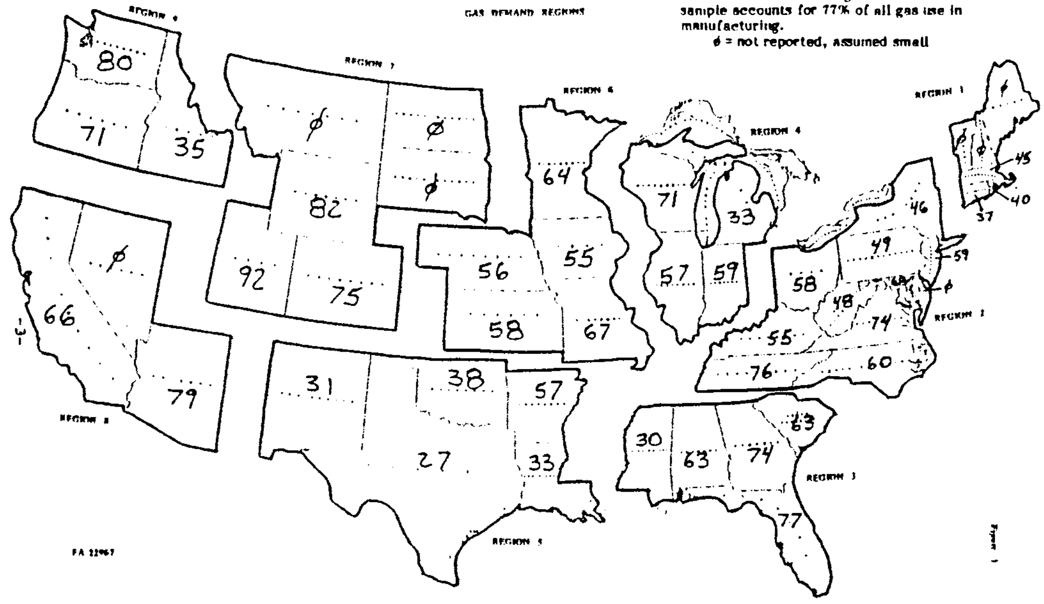
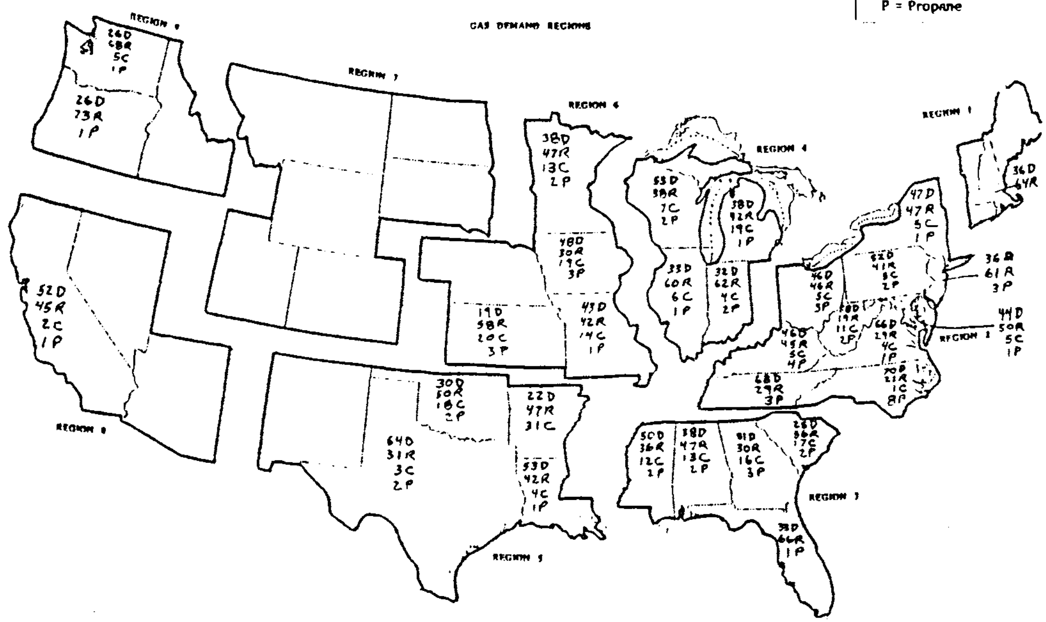


Figure 21. - Manufacturing % Substitution to

based on Census data

D = Distillate
R = Residual
C = Coal
P = Propane



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7. Emission Coefficients

Emission coefficients for all pollutants studied were taken from the data base of the SEAS model. The air pollutant coefficients were developed on an AQCR basis using the present emission regulations (State Implementation Plan or SIP regs) [4]. An analysis of NSPS (New Source Performance Standards) regulations showed that many state SIP requirements are already as stringent as the NSPS requirements so that their inclusion would not make much of a difference in the impact calculations. The effect of NSPS might be to reduce the impact of permanent switching somewhat. No effect would be expected on the winter season curtailment induced emissions except possibly in the case where stand-by fuel use is not permitted an emergency waiver; but, instead, deemed a major modification subject to NSPS. This seems a very extreme case, however.

C. Assumptions used in Analyzing Policies

This section reviews some key assumptions which were required in order to use the environmental model described previously to simulate the effects of alternate curtailment policy options. There are two types of assumptions involved: (1) assumptions about how gas is actually delivered to the 54 AQCR's under study, and (2) assumptions about how the level of curtailment and the level of demand will change in response to different policy options (the diamond shapes in Figure 16). These will be covered in two sections, below.

1. Assumptions About the Delivery System

In actuality, an area such as an air quality control region may be served by several local gas distribution companies each of which is served by several pipeline companies. In this situation, it is not unusual that the level of end use curtailment actually experienced is a very complex function of the level of shortfall, the type of curtailment plan, and the extent of storage capability on each of the distribution companies and each of the pipeline companies. This problem is far too intricate and too far beyond the extent of available data to be modelled precisely at a programmatic level. It requires the enlistment of some simplifying assumptions.

Using Brown's Directory of North American Gas Companies [14] and other available sources, the major pipelines serving each of the 54 AQCR's were identified. From many

of the same sources, estimates of the percent of total AQCR demand supplied by each pipeline were derived. This simplified model of the delivery system provides a good rough cut at defining the major pipelines influencing each AQCR. It is further assumed that different distribution companies within the same AQCR are likely to face the same curtailment prospects. This will not be true in all cases, but there is some evidence to suggest that it is not too bad an approximation.

2. Assumptions About Demand and Curtailment Under Alternate Policies

a. Do-Nothing Alternative

The curtailments for the do-nothing case were taken from the results of the simulation modelling of prototype pipelines and extrapolated to the 25 pipelines comprising the environmental model. This procedure was described in a preceding section.

b. Agriculture Priority

The agriculture priority was simulated by estimating the extent of essential agricultural demand in each AQCR and deleting this amount from the curtailable demand in the process category. According to the USDA draft EIS on the proposed agriculture priority [10] , 78% of agricultural gas use is in food processing and fertilizer production. The fertilizer portion (35%) is treated here as a process/feedstock use. The food processing portion (43%) is estimated for each AQCR by taking gas use in SIC 20 (Food and Kindred Products) from the U.S. Census Survey of Manufacturers data. The amount of agricultural gas thus estimated for each AQCR is given as the percent that it comprises of demand in the process category are given in Table 25.

c. Process and Feedstock Priority

The process and feedstock priority was simulated by assuming that it would have the effect of cutting the amount of curtailments in the process and feedstock category by 50%.

d. Percent Limit Rule

The percent limit rule was simulated by simply reducing demand in all categories by 20%.

TABLE 25. - AGRICULTURAL DEMAND IN SIC 20 FOR 54 AQCR's AS A % OF TOTAL PROCESS DEMAND

AQCR		Agricultural Portion of Process Demand Category (%)
004	Birmingham, Ala.	4
005	Mobile-Pensacola	5
007	Florence, Ala.	1
016	Little Rock, Ark.	6
018	Memphis, Tenn.	47
019	Monroe, La.	1
024	Los Angeles, Ca.	20
030	San Francisco, Ca.	28
031	Stockton, Ca.	90
036	Denver, Co.	77
038	Pueblo, Co.	1
043	New York, N.Y.	23
045	Philadelphia, Pa.	7
053	Augusta, Ga.	6
055	Chattanooga, Tenn.	19
056	Atlanta, Ga.	23
067	Chicago, Ill.	18
069	Quad Cities, Iowa	26
070	St. Louis, Mo.	31
078	Louisville, Ky.	50
079	Cincinnati, Ohio	39
080	Indianapolis, Ind.	11
088	Cedar Rapids, Iowa	90
094	Kansas City, Kan.	26
099	Wichita, Kan.	18
103	Huntington, W.Va.	1
106	Baton Rouge, La.	3
115	Baltimore, Md.	23

	AQCR	Agricultural Portion of Process Demand Category (%)
122	Grand Rapids, Mich.	12
123	Detroit, Mich.	4
124	Toledo, Ohio	7
125	Kalamazoo, Mich.	11
131	Minneapolis, Minn.	50
153	El Paso, Tex.	13
162	Buffalo, N.Y.	14
173	Dayton, Ohio	23
174	Cleveland, Ohio	4
176	Columbus, Ohio	34
177	Lima, Ohio	9
178	Youngstown, Ohio	1
181	Steubenville, Ohio	1
186	Tulsa, Okla.	3
193	Portland, Ore.	20
197	Pittsburgh, Pa.	2
208	Nashville, Tenn.	12
214	Corpus Christi, Tex.	8
215	Dallas-Ft.Worth, Tex.	29
216	Houston, Tex.	3
218	Odessa, Tex.	1
220	Salt Lake City, Utah	15
229	Seattle, Wash.	20
234	Charleston, W.Va.	1
237	Appleton-Oshkosh, Wisc.	19
239	Milwaukee, Wisc.	49

e. Pricing

The anticipated effect of a pricing approach would be that some users would be less willing to pay for gas than others. This was simulated by moving 40% of the demand in the commercial category into the small boiler category and reducing curtailments in the process category by 30%.

f. Beyond Curtailment — Modified Rates

This option was not simulated as the input assumptions would be essentially the same as those for the pricing option.

g. Rolling Base and Pro Rata

These options were not simulated as they would simply impose minor rearrangements of curtailment in a somewhat arbitrary fashion, the details of which are not known. The net effect on a nationwide basis would likely be little change from the emissions produced by the do-nothing case. The major impact of these options may be permanent switching induced by failing user confidence.

h. Improved 467-B

This option was simulated using a different version of the environmental model as described in Section V. No assumptions regarding demand or curtailments were required.

Part 3: Basis for Analysis of Other Environmental, Health and Safety Issues

The estimates of other pollutants generated by curtailment such as water pollutants and solid wastes are based on emission coefficients taken from the SEAS model data base [4].

The estimates of the quantities of alternate fuels entailed are based on the curtailments and substitution coefficients from the do-nothing case for the 1981 Base Case (1-in-10) demand.

Part 4: Points of NEPA

This section provides summary discussions of the potential impacts of alternative natural gas curtailment policies in terms of several important considerations specified by NEPA and CEQ.

A. Unavoidable Adverse Effects

During winter season episodes of natural gas curtailment, the substitution of alternate fuels produces additional emission increments which are unavoidable. The average of these emission increments over the winter season is very small in most places. From one curtailment policy to the next, the difference in the size of the average increments is negligible. It is also unavoidable, however, that there may be some exceptions to these general conlcusions: in instances where curtailed emission sources are unusually concentrated, where extreme levels of curtailment happen during periods of unusually poor dispersive conditions, and where gas is the predominant fuel in a local area. Provision for an exemption procedure can reduce the likelihood of these exceptions.

B. Relationship Between the Short-Term Uses of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity

Perhaps the only impact falling directly under this category is the contribution of curtailment induced emission increments to the acid rain problem. Analyses in Section V show that the emission increments are very small relative to the level of emissions from other sources. The contribution of curtailment to acid rain is probably proportionately small. The net difference between alternative curtailment policies in this regard is negligible.

Another issue possibly considered in this category is the matter of different time preferences for expending our finite resources of natural gas. Opponents of coal and oil conversion programs have sometimes argued, on the basis of preserving the long-term productivity of the global environment, that natural gas should be fully exploited in the near-term as the cleanest swing-fuel that can sustain the economy until an environmentally sound renewable-source energy future can be mobilized. This is also a question of resource commitment and is discussed in the next section.

C. Irreversible and Irretrievable Commitments of Resources

In the context of a short-run shortage of natural gas, the fallback position from the long-run philosophy described above would probably be reflected in the "best environmental" alternative examined in Section V. This analysis addresses the question of how best to commit irreplaceable gas resources in the short-run from the standpoint of minimizing air quality impact.

The conclusions of the best case analysis in Section V indicate that the most important air quality impacts are likely to be in special circumstances where emissions from alternate fuels are unusually concentrated. In these circumstances the clean characteristics of the fuel would be valued most highly. The recommendation that any curtailment policy provide for these special exceptions would assure that the pollution-free properties of the resource are valued in the allocation process. A pricing alternative may have unique advantages in performing this allocation.

D. Relationship to Land Use Plans and Policies

Federal air quality regulations have had an effect on land use in industrial areas in the 1970's. In Section V a "best environmental" alternative was developed by imitating these air qualtiy regulations with respect to natural gas curtailment. Were such a curtailment policy implementable, it could have profound effects on industrial land use. But for these and other reasons, such a policy is not seriously feasible. This case does, however, highlight the potentially strong influence of any air quality approach to curtailment on local land use.

The recommendation for providing special case treatment in instances of unusually concentrated curtailment impacts is a "next-best" environmental strategy and land use implications follow. The ultimate effect of granting exemptions on this basis could be to encourage concentrated industrial development. While this is an item to consider, it seems that there are many countervieling forces including local land use regulation, local air quality regulation, and specially designed curtailment regulations that could be brought to bear on this problem to prevent this type of side effect.

E. Effects on Historic Sites

In this totally non-site-specific study it is not possible to account for all potential effects on historic and cultural resources listed on, or potentially eligible for, the National Register of Historic Places. This responsibility must be carried out below the programmatic level and would be included in any procedure developed to handle special exceptions.

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National Association of Regulatory Utility Commissioners

National Coal Association

American Petroleum Institute

National Petroleum Refiners Association

National Association of Manufacturers

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X. INDEX

XI APPENDIX A: REFERENCES

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XII. APPENDIX B - PUBLIC REVIEW AND COMMENT ON THE DRAFT EIS

Part 1. Public Review Process

The Draft EIS was circulated to the parties listed in Section IX in conjunction with the Draft Regulatory Analysis and the proposed rule (10 CFR Part 580). Additional copies were circulated to those requesting them. The rulemaking procedures required a longer review and comment period than the normal EIS review thus extending the Draft EIS review period to over two months. Late comments were accepted. Public notice of availability was provided by the standard EPA announcement in the Federal Register and by standard DOE public notice procedures for both impact statements and rulemaking proceedings.

Public hearings were held in Washington, D.C.; Atlanta, Georgia; Houston, Texas; Chicago, Illinois; and San Francisco, California. Over one hundred and fifty written and oral comments were received on the proposed rule. Twenty-four comments were received on the Draft EIS. The comments on the proposed rule were reviewed to determine if any of them contained substantive comments on the Draft EIS. One such comment from the State of Louisiana was found and has been incorporated in this section of the Final EIS.

Part 2. Responses to Comments

Of the comments received on the Draft EIS, only six were substantive in nature. The remainder express either no interest in the proposed action or no objection to it. The substantive comments are individually abstracted in this part and individual responses are provided for each. None of the responses entailed any substantive changes in the body of the EIS. However, additional wording has been added in a few places to clarify or elaborate on the points raised.

A. Responses to Comments of the U.S. Environmental Protection Agency

Comment: The U.S. Environmental Protection Agency (EPA) has reviewed the Draft Environmental Impact Statement (EIS) for Establishment of Natural Gas Curtailment Priorities. On the basis of our review, we have assigned the

document a rating of "LO-1," which means that EPA has no significant objections to the proposed action and that the EIS adequately assessed the environmental impacts likely to concern EPA.

Response: No response required.

Comment: EPA suggests however, that you expand in the final EIS your description of the environmental exemption procedure envisioned for administration by the Federal Energy Regulatory Commission under Section 502 of the Natural Gas Policy Act. We recommend that in addition to those cases already contemplated in the draft, the final EIS discuss applying the exemption procedure in any area which is violating ambient air quality standards for sulfur dioxide and/or total suspended particles. EPA would have a strong interest in this proposal and would appreciate being involved in the development of any rulemaking concerning environmental exemption procedures under Section 502 of the NGPA.

Response: The exemption procedure envisioned (pages 52 and 53 of either the Draft or Final EIS) will allow the Federal Energy Regulatory Commission (FERC) to grant an exemption from curtailment rules, under authority of Section 502 of the NGPA, in any exceptional cases where the impacts of alternate fuel use may be particularly severe. This will be a case-by-case procedure administered by FERC. Before considering any application for an exemption, FERC will publish a notice of such proceedings in the Federal Register. The Environmental Protection Agency, State or local air quality agencies, and any other interested parties may intervene in the exemption proceedings at that point.

This exemption procedure has been described to EPA staff identified in the comment for telephone contact and found to be satisfactory.

The comment also asks that the EIS discuss applying the exemption procedure to any area which is violating ambient air quality standards for sulfur dioxide and/or total suspended particulates. This concept is covered in depth in the Best Case Analysis (pages 46 through 53 of either the Draft or Final EIS). It was found that there are so many areas in non-

attainment of sulfur dioxide and particulate standards that this approach is unworkable at a programmatic level. The next best alternative, therefore, is to examine exemption requests on a case-by-case basis, which is the proposed exemption procedure.

B. Responses to Comments of the U.S. Department of the Interior

Comment: The draft statement does not assess specific environmental impacts from the increased use of fuel substitutes. Parameters such as land disturbance, generation of solid wastes and water pollution should be estimated and related to local situations.

Response: Land disturbance, solid waste generation, water pollutants, and other non-air quality impacts of increased use of fossil fuels during periods of curtailment are addressed in the EIS (pages 62 through 65 of either the Draft or Final EIS). To the extent possible these impacts are quantified at a national level for a typical curtailment case. As stated in the Draft EIS, the ultimate site-specific impacts in these categories cannot be precisely determined. The chain of causation which produces the final impact is many steps removed from Federal gas curtailment policy.

Comment: Further, the discussion in "Irreversible and Irretrievable Commitments of Resources" should idenntify and quantify the types of fuel substitutes that might be used for natural gas at some future time.

Response: In the context of the "Irreversible and Irretrievable Commitments of Resources" discussion (page 102 of either the Draft or Final EIS), this comment asks: "What fuels will be used after natural gas resources have been exhausted?" This question cannot be reliably answered at this time. The discussion on page 102 makes the point that we should try to make the best use of natural gas while it lasts. This includes the best use of its clean burning properties. Though the mix of future substitutes is not known, the current quantities of alternate fuels used during curtailment have been estimated in the EIS (page 63 of either the Draft or Final EIS).

C. Responses to Comments of the Department of Health and Human Services, Office of The Secretary

<u>Comment:</u> The document gives extensive information on the anticipated comprehensive review of alternatives to the existing federal policy on curtailment of natural gas deliveries during periods of fuel shortage. It identifies that residential and small users of natural gas cannot be curtailed effectively and cutbacks are focused on larger users, primarily in the industrial and electrical utility sectors.

However, we expect that the curtailment of natural gas will have some minimum social, economic and environmental impact on the general public in terms of cost increases caused by switching away from natural gas and substituting energy fuels, and by becoming aware of how the increase of air pollution and contamination of water might inhibit their health conditions.

We are deeply concerned about the welfare of the elderly, handicapped individuals, the children and the poor representing a considerable portion of the Nation's population. They may require in the situation of these socio-economic impacts, the availability of comprehensive social services and resources in the community to address their needs. On the other hand, we find that this project will have no adverse effects on the people we are concerned about in the anticipated natural gas curtailment.

<u>Response:</u> No response required.

D. Responses to Comments of the Department of Health and Human Services, Public Health Service

<u>Comment:</u> In general, we have no major objections to the proposed curtailment policies for reducing economic and environmental impacts. However, the potential impact of the gas curtailment policies upon air quality and other environmental concerns should also be related to human health. We understand that the preferred alternative is called the "improved 467-B." This rationing alternative involves no changes from the present curtail-

ment policies except those mandated by the Natural Gas Policy Act for essential agricultural, industrial process, and feedstock uses and the encouragement for improved gas transport. With improved gas transport, interstate price variation of natural gas and the gas supply imbalance can be reduced. While interstate wellhead prices of all gas destined for interstate marketing are regulated, we realize that intrastate transactions are not controlled. We believe the effect that intrastate gas prices and its supply and demand has had on interstate transactions and curtailment of natural gas should be discussed in the EIS.

Response: Part 3 of Section V of either the Draft or the Final EIS presents the detailed discussion of the approach taken to the air quality analysis of gas curtailment policies. On page 18, and in several other locations it is noted that this analysis was undertaken with the assumption that intrastate pipelines could be made subject to Federal curtailment policies. This was done to assure that the best conceivable environmental alternative was considered, regardless of the actual limits of authority. It was found (analysis from pages 15 to 62) that despite the additional quantities of clean burning gas made available by this assumption, optimal reallocations of this gas could not be easily determined on the basis of air quality criteria. The problem is that there is no solution capable of making everyone better off that does not entail making some people worse off. The loss of gas by intrastate customers was shown to have bad effects on air quality in the gas producing states. In terms of the relationship of air quality criteria to health effects, the analysis showed that the same interregional trade-offs are entailed and there is no best alternative.

Comment: In local areas where natural gas is the predominant fuel and where air quality problems exist or could occur with large curtailments, we strongly support the development and implementation of special curtailment regulations and emergency procedures to mitigate adverse air pollution episodes and continued violation of air quality standards as a result of curtailment activities. Every effort must be made to protect public health.

Response: No response required.

Comment: Consideration should be given to providing incentives for industrial and agricultural concerns to replace the long-term use of natural gas with clean alternative fuels and/or energy systems. This would free up natural gas for use by those areas that are more dependent upon gas, are exhibiting adverse air quality problems, and are economically incapable of making a transition to alternate fuels.

Response: The best incentive system for achieving these objectives would probably be the pricing strategies examined in the EIS. Other types of incentives independent of curtailment policy represent broader issues of national energy policy that are not the subject of this EIS.

Comment: The EIS indicates that residential and other small users cannot be effectively curtailed. Curtailment is instead directed towards larger industrial and agricultural users. Has consideration been given to the use of additional tax credit benefits and other incentives to cut down on the residential use of natural gas? Improved insulation, energy efficient designs, and incorporation of supplemental heating systems could reduce residential use of gas.

Response: Some very aggressive conservation programs are being pursued by DOE in the residential and small commercial sectors under provisions of the National Energy Conservation Policy Act of 1978. Conservation initiatives were accounted for in the demand projections which were used in the EIS analysis of curtailment policy.

Comment: Have escalating wellhead prices and exploration/production costs resulted in less exploration/production efforts with a steady decline in our proven natural gas reserves? What legislative and executive efforts are being made to improve exploration and acquisition of gas from harder-to-reach places and to reduce natural gas curtailment until an environmentally-sound energy system can be developed and economically distributed?

Response: Production incentives are a separate issue from natural gas curtailment policy. The scope of the EIS is to search for better contingency plans for managing gas supplies under conditions of shortage.

E. Responses to Comments of the state of North Carolina, Department of Natural Resources and Community Development

Comment: The Division of Environmental Management requests that at a minimum, State and local agencies should be informed when shortages are anticipated for SO_2 or particulate non-attainment areas.

Response: The prediction of gas shortages on a local geographic basis is a task which cannot be undertaken with certainty at a Federal or centralized level, especially as gas distribution networks do not correspond to air quality control regions. Perhaps the best early warning system would be to establish contacts with major distributors and major fuel users at the local level.

F. Responses to Comments of the State of Louisiana

Comment: Louisiana has an acute concern for the environmental impact of natural gas curtailment for two reasons: first, as the EIS shows, Louisiana's economy is extremely gas dependent. Natural gas curtailment policies therefore affect Louisiana proportionately more than they affect other regions of the country. Second, large portions of Louisiana have been identified by the Environmental Protection Agency as non-attainment areas which do not meet federal air quality standards. Heavy curtailment of Louisiana's industries will make a bad situation worse. Both of these facts should be considered in determining the environmental impact of curtailment changes which affect United. Louisiana agrees that considerations which are specific to particular regions can best be addressed at the time the FERC devises the allocation mechanisms to implement the ERA rule. That is true, however, only on the assumption that FERC retains and will exercise the discretion to devise the best allocation mechanism for a pipeline and its region. If, on the other hand, the ERA

rule were intended to impose a single "rule of thumb" allocation mechanism or to preclude FERC from considering the distinctions between partial and full requirements customers when it implements the priorities established by ERA, the environmental effects of that decision on Louisiana should be specifically considered at this time. The existing EIS is inadequate to analyze the environmental impact of such an allocation mechanism because the EIS does not consider the effects of a curtailment program which will result in the curtailment of higher priority customers in one region for the benefit of lower priority customers in another.

Response: The environmental exemption procedure envisioned for administration by FERC would allow FERC the necessary flexibility to apply the national level curtailment priorities to the unique circumstances existing along individual pipelines. The exemption provided for under Section 502 of NGPA can be based on circumstances of economic or environmental hardship, or both.

The curtailment of high priority users in one area to serve low priority users in another area is a different issue. Since Federal curtailment priorities apply only on a voluntary basis to intra-state sales, this type of inequity cannot be completely eliminated by any policy alternative.

Part 3. Letters of Comment

Letters of comment received on the Draft EIS are reproduced in the remainder of this section.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

25 AUG 1980

791044A

OFFICE OF THE
ADMINISTRATOR

Docket No: ERA-R-79-10
Public Hearing Management
2000 M St., N.W., Room 2313
Washington, D.C.

Dear Sir or Madame:

The U.S. Environmental Protection Agency (EPA) has reviewed the Draft Environmental Impact Statement (EIS) for Establishment of Natural Gas Curtailment Priorities. On the basis of our review, we have assigned the document a rating of "LO-1", which means that EPA has no significant objections to the proposed action and that the EIS adequately assessed the environmental impacts likely to concern EPA.

EPA suggests however, that you expand in the final EIS your description of the environmental exemption procedure envisioned for administration by the Federal Energy Regulatory Commission under Section 502 of the Natural Gas Policy Act. We recommend that in addition to those cases already contemplated in the draft, the final EIS discuss applying the exemption procedure in any area which is violating ambient air quality standards for sulfer dioxide and/or total suspended particulates. EPA would have a strong interest in this proposal and would appreciate being involved in the development of any rulemaking concerning environmental exemption procedures under Section 502 of the NGPA.

Thank you for the opportunity to comment on this draft EIS. For further coordination on the exemption procedure, please contact George Sugyama at 426-2482. For coordination of other matters concerning the EIS, please contact Thomas Pierce at 755-0780.

Sincerely yours,

for Tom Sheckells
William N. Hedeman, Jr.
Director
Office of Environmental Review

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

ER 80/680

AUG 19 1980

791047A

ERA-R-77-10A

Department of Energy
Office of Public Hearings
2000 M Street, N.W., Room B-210
Washington, D.C. 20461

Dear Sir:

We have reviewed the draft environmental impact statement and regulatory analysis for Review and Establishment of Natural Gas Curtailment Priorities and have the following comments.

The draft statement does not assess specific environmental impacts from the increased use of fuel substitutes. Parameters such as land disturbance, generation of solid wastes and water pollution should be estimated and related to local situations. Further, the discussion in "Irreversible and Irretrievable Commitments of Resources" should identify and quantify the types of fuel substitutes that might be used for natural gas at some future time.

We hope these comments will be helpful to you in the preparation of a final statement.

Sincerely,

James H. Rathlesberger
Special Assistant to
Assistant SECRETARY

DEPARTMENT OF HEALTH AND HUMAN SERVICES
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20201

Mr. Albert F. Bass
Department of Energy
2000 M. Street, N.W., Room 7108
Washington, D.C. 20461

AUG 13 1980

Dear Mr. Bass:

Thank you for the opportunity to review and comment on the Draft Environmental Impact Statement for the Review and Establishment of Natural Gas Curtailment Priorities, prepared by the Regulatory Administration, in Washington, D.C.

The document gives extensive information on the anticipated comprehensive review of alternatives to the existing federal policy on curtailment of natural gas deliveries during periods of fuel shortage. It identifies that residential and small users of natural gas cannot be curtailed effectively and cutbacks are focused on larger users, primarily in the industrial and electrical utility sectors.

However, we expect that the curtailment of natural gas will have some minimum social, economic and environmental impact on the general public in terms of cost increases caused by switching away from natural gas and substituting energy fuels, and by becoming aware of how the increase of air pollution and contamination of water might inhibit their health conditions.

We are deeply concerned about the welfare of the elderly, handicapped individuals, the children and the poor representing a considerable portion of the Nation's population. They may require in the situation of these socio-economic impacts, the availability of comprehensive social services and resources in the community to address their needs. On the other hand, we find that this project will have no adverse effects on the people we are concerned about in the anticipated natural gas curtailment.

If you have any question about our concerns, please contact Mr. Max Wenk of my staff. Mr. Wenk can be reached on (202) 472-4415.

Sincerely,

Warren Master, Director
Office of Policy Development

DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTER FOR DISEASE CONTROL
ATLANTA, GEORGIA 30333

August 1, 1980

Mr. Lynne H. Church
Director, Division of Natural Gas
Department of Energy
Washington, D.C. 20461

Dear Mr. Church:

We have reviewed the Draft Environmental Impact Statement (EIS) for the Review and Establishment of Natural Gas Curtailment Priorities. We are responding on behalf of the U.S. Public Health Service and are offering the following comments for your consideration in preparing the Final EIS.

In general, we have no major objections to the proposed curtailment policies for reducing economic and environmental impacts. However, the potential impact of the gas curtailment policies upon air quality and other environmental concerns should also be related to human health. We understand that the preferred alternative is called the "improved 467-B." This rationing alternative involves no changes from the present curtailment policies except those mandated by the Natural Gas Policy Act for essential agricultural, industrial process, and feedstock uses and the encouragement for improved gas transport. With improved gas transport, interstate price variation of natural gas and the gas supply imbalance can be reduced. While interstate wellhead prices of all gas destined for interstate marketing are regulated, we realize that intrastate transactions are not controlled. We believe the effect that intrastate gas prices and its supply and demand has had on interstate transactions and curtailment of natural gas should be discussed in the EIS.

In local areas where natural gas is the predominant fuel and where air quality problems exist or could occur with large curtailments, we strongly support the development and implementation of special curtailment regulations and emergency procedures to mitigate adverse air pollution episodes and continued violation of air quality standards as a result of curtailment activities. Every effort must be made to protect public health.

Consideration should be given to providing incentives for industrial and agricultural concerns to replace the long-term use of natural gas with clean alternative fuels and/or energy systems. This would free up natural gas for use by those areas that are more dependent upon gas, are exhibiting adverse air quality problems, and are economically incapable of making a transition to alternate fuels.

The EIS indicates that residential and other small users cannot be effectively curtailed. Curtailment is instead directed towards larger industrial and agricultural users. Has consideration been given to the use of additional

tax credit benefits and other incentives to cut down on the residential use of natural gas? Improved insulation, energy efficient designs, and incorporation of supplemental heating systems could reduce residential use of gas.

Have escalating wellhead prices and exploration/production costs resulted in less exploration/production efforts with a steady decline in our proven natural gas reserves? What legislative and executive efforts are being made to improve exploration and acquisition of gas from harder-to-reach places and to reduce natural gas curtailment until an environmentally-sound energy system can be developed and economically distributed?

We appreciate the opportunity to review this EIS. Please send us one copy of the final document when it becomes available. Should you have any questions regarding our comments, please contact Mr. Robert Kay or me at FTS 236-6649.

Sincerely yours,

F. S. Lisella

Frank S. Lisella, Ph.D.
Chief, Environmental Affairs Group
Environmental Health Services Division
Bureau of State Services

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON, D.C. 20426

Mr. F. Scott Bush
Assistant Administration for
Regulations and Emergency
Planning
Economic Regulatory Administration
Department of Energy
Washington, D.C.

JUL 17 1980

Dear Mr. Bush:

This will acknowledge and respond to your letter dated June 26, 1980 to the Secretary of the Commission. That letter gave notice to the Commission under Section 404(a) of the Department of Energy Organization Act (DOE Act) of the Economic Regulatory Administration's proposed rule regarding the establishment and review of natural gas curtailment priorities for interstate pipelines, and transmitted a copy of the notice of proposed rulemaking.

Based upon a review of the notice of proposed rulemaking, the Commission has determined that the proposed rule may significantly affect a function within the jurisdiction of the Commission pursuant to Section 402(a)(1) of the DOE Act. Accordingly, you are advised that the Commission takes referral of this matter under the procedures of Section 404 of the DOE Act.

By direction of the Commission.

Kenneth F. Plumb

Secretary

cc: Hazel R. Rollins
Lynne H. Church

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Policy
Washington, D.C. 20230

JUL 1 8 1980

Mr. Lynne H. Church
Director, Division of
Natural Gas
U.S. Department of Energy
Washington, D.C. 20461

Dear Mr. Church:

Your notice to the Secretary transmitting a copy of the draft environmental impact statement, "Review and Establishment of Natural Gas Curtailment Priorities" has been referred to the Office of Environmental Affairs for coordination of review and comment.

We appreciate the opportunity to review this document and will be in touch with you if we have any comments concerning it.

Sincerely,

Robert T. Miki
Deputy Assistant Secretary for
Regulatory Policy (Acting)

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

WASHINGTON, D.C. 20410

OFFICE OF THE ASSISTANT SECRETARY
FOR COMMUNITY PLANNING AND DEVELOPMENT

IN REPLY REFER TO:

JUL 23 1980

Ms. Lynne H. Church
Director, Division of Natural Gas
Department of Energy
Washington, D. C. 20461

Dear Ms. Church:

Subject: Draft Environmental Impact Statement
Review and Establishment of Natural
Gas Curtailment Priorities

We appreciate being given the opportunity to comment on the above draft Environmental Impact Statement. We have reviewed the draft and have no comments to make.

Sincerely,

George A. Karas

George A. Karas
Director, Environmental
Review Division

STATE OF ALASKA

OFFICE OF THE GOVERNOR

DIVISION OF POLICY DEVELOPMENT AND PLANNING

JAY S. HAMMOND, Governor

POUCH AD
JUNEAU, ALASKA 99811
PHONE: 465-3573

August 14, 1980

Mr. Albert F. Bass
Department of Energy
2000 M Street N.W. Room 7108
Washington, D.C. 20461

Subject: DOE/EIS Natural Gas Curtailment Review - Vol. 3
State I.D. No. FE040-80071502ES

Dear Mr. Bass:

The Alaska State Clearinghouse (SCH) has completed review of the referenced project.

The following comment was received from the Department of Law:

> "The Department of Law has no comments upon the Environmental Impact Statement concerning natural gas curtailment review. Although the department does have an interest in the eventual rule arising concerning rationing and curtailment of natural gas during periods of shortage, particularly with regard to the rules concerning allocation and the impact on the State's flexibility in disposing of its royalty gas and gas liquids, the matters discussed in the draft environmental impact statement are not of direct concern to this department.
>
> "We would, however, be interested in receiving other documents on this subject as they come in. Thank you for your consideration."

The SCH has no objection to this proposal.

This letter satisfies the review requirements of OMB Circular A-95.

Thank you for your cooperation with the review process.

Sincerely,

Michael Whitehead
Michael Whitehead
State-Federal Coordinator

cc: Robert M. Maynard, Department of Law

01-A3LH

JFA

SIGNOFF

OMB Approval No. 29–R0218

FEDERAL ASSISTANCE

2. Applicant's application — a. Number: ; b. Date: 19 Year Month Day

3. State application identifier — a. Number: AZ 80-80-0046; b. Date Assigned: 19 80 08 19 (Year month day)

Leave Blank: SEP 22 1980

JoAnn (Youngblood) Stephens

1. Type Of Action (Mark appropriate box)
- ☐ Preapplication
- ☐ Application
- ☐ Notification Of Intent (Opt.)
- ☐ Report Of Federal Action

4. Legal Applicant/Recipient

a. Applicant Name : U.S. Dept. of Energy
b. Organization Unit : Economic Regulatory Administration
c. Street/P.O. Box : 2000 M Street, N.W., Room 7108
d. City : Washington   e. County :
f. State : D.C.   g. Zip Code : 20461
h. Contact Person (Name & telephone no.) : Albert F. Bass or Paula Daigneault (202) 653-3286

5. Federal Employer Identification No.

6. Program (From Federal Catalog)
a. Number 81.099
b. Title Unknown
Dept. of Energy
Off. of Regulations & Emergency Planning

7. Title and description of applicant's project Regulatory Analysis for Review and Establishment of Natural Gas Curtailment Priorities Vol. I Overall Regulatory Perspective, Vol. II Evaluation of Policy Alternatives, Vol. III Draft Environmental Impact Statement, Vol. IV Appendices-This report discusses important differences among alternatives for establishing natural gas curtail priorities to deal with long run supply shortages and short run capacity shortages.

8. Type of applicant/recipient
A–State, B–Interstate, C–Substate District, D–County, E–City, F–School District, G–Special Purpose District, H–Community Action Agency, I–Higher Educational Institution, J–Indian Tribe, K–Other
(Specify): Federal
Enter appropriate letter: K

9. Type of assistance
A–Basic Grant, B–Supplemental Grant, C–Loan, D–Insurance, E–Other
Enter appropriate letter(s): e

10. Area of project impact (Names of cities, counties, states, etc.)
Statewide, Arizona

11. Estimated number of persons benefiting

12. Type of application
A–New, B–Renewal, C–Revision, D–Continuation, E–Augmentation
Enter appropriate letter: a

13. Proposed Funding

a. Federal	$	.00
b. Applicant		.00
c. State		.00
d. Local		.00
e. Other	1	.00
f. Total	$ 1	.00

14. Congressional Districts Of: a. Applicant ; b. Project 01,02,03,04

15. Type of change (For 12c or 12e)
A–Increase Dollars, B–Decrease Dollars, C–Increase Duration, D–Decrease Duration, E–Cancellation, F–Other Specify:
Enter appropriate letter(s)

16. Project Start Date 19 Year month day

17. Project Duration Months

18. Estimated date to be submitted to federal agency 19 Year month date

19. Existing federal identification number

20. Federal agency to receive request (Name, city, state, zip code)

21. Remarks added ☐ Yes ☐ No

22. The Applicant Certifies That

a. To the best of my knowledge and belief, data in this preapplication/application are true and correct, the document has been duly authorized by the governing body of the applicant and the applicant will comply with the attached assurances if the assistance is approved.

b. If required by OMB Circular A-95 this application was submitted, pursuant to instructions therein, to appropriate clearinghouses and all responses are attached:

	No response	Response attached
(1) Arizona State Clearinghouse	☐	☒
(2) Region Clearinghouses I, II, III, IV, V	☐	☒
(3)	☐	☐

23. Certifying representative — a. Typed name and title; b. Signature; c. Date signed 19 Year month day

24. Agency name

25. Application received 19 Year month day

26. Organizational Unit

27. Administrative office

28. Federal application identification

29. Address

30. Federal grant identification

31. Action taken
- ☐ a. Awarded
- ☐ b. Rejected
- ☐ c. Returned for amendment
- ☐ d. Deferred
- ☐ e. Withdrawn

32. Funding

a. Federal	$	.00
b. Applicant		.00
c. State		.00
d. Local		.00
e. Other		.00
f. Total	$	.00

33. Action date 19 Year month day

34. Starting date 19 Year month day

35. Contact for additional information (Name and telephone number)

36. Ending date 19 Year month day

37. Remarks added ☐ Yes ☐ No

38. Federal agency A–95 action

a. In taking above action, any comments received from clearinghouses were considered. If agency response is due under provisions of Part 1, OMB Circular A-95, it has been or is being made.

b. Federal Agency A-95 Official (Name and telephone number)

Section I - Applicant / Recipient Data
Section II - Certification
Section III - Federal Agency Action

STATE OF COLORADO

OFFICE OF ENERGY CONSERVATION
Office of the Governor
1600 Downing Street, 2nd Floor
Denver, Colorado 80218
Phone (303) 839-2507, 839-2186

Richard D. Lamm,
Governor

M. Buie Seawell,
Executive Director

MEMORANDUM

AUG 29 1980
DIV. OF PLANNING

DATE: August 27, 1980

TO: Colorado Clearinghouse

FROM: Office of Energy Conservation

SUBJECT: Draft Environmental Impact Statement for Programmatic Review and Establishment of Natural Gas Curtailment Priorities. #80-142

The Colorado Office of Energy Conservation has briefly reviewed the above referenced draft programmatic EIS and offers the following general comments.

This office is supportive of a "beyond curtailment" alternative in which other long-term energy policies are combined with curtailment measures. A combination curtailment-management alternative would better allow system flexibility with some constancy of guidelines and long-term management capability. Rate structures which support energy conservation goals are shown to be the least costly of all alternatives considered in terms of user shortage impact costs and total costs. This office is pleased to see a thorough and comprehensive discussion on these issues and also favors moves to ease the transfer of natural gas between distribution systems to help solve the geographical supply problems and promote a more equitable sharing of potential shortages.

DF:pl

STATE CLEARINGHOUSE
Intergovernmental Coordination
Office of the Governor
The Capitol
Tallahassee, Florida 32301
904/488-8114

Date received: 07/10/80

SAI Number: 810010

We have received your recent correspondence concerning the project identified by your title DOE - draftEIS 0065 Natural Gas Curtailment Priorities

This review begins on the day the item was received in our office, pursuant to U.S. OMB Circular A-95 and/or Section 216.212, F.S. Please refer to the above State Application Identifier (SAI) Number in any future correspondence concerning the project.

The target date for completion of our review and dispatch of comment is this date plus 30 days. Completion of action may be delayed if we need to review the completed application, in which case we will notify you.

Ron Fahs
Director, Intergovernmental Coordination

*Copies should also be sent to regional and metropolitan clearinghouses.

(NOTE: Office location - 403 Carlton Bldg.)

PROJECT REVIEW/RESPONSE A-95

State Form 762

State Application Identifier No.		
80 0712 0000		
Date Received	Date Review Ends	Date Receipt Sent
7/3/80	8/3/80	7/9/80

tructions: 1. To REVIEWING STATE AGENCY - This grant application is referred to your agency for review and comments. If your agency has an interest in this grant application, please complete this page. Your cooperation is asked in returning this review to the State Clearinghouse within 25 days of receipt. Please keep the appropriate copy for your files.

2. To APPLICANT - This form is the A-95 Response of the State Clearinghouse and it is to be attached to your formal application.

TO

Reviewing Agency

Jon Satrom
Bd. of Health

RECEIVED
JUL 11 1980
INDIANA STATE BOARD OF HEALTH
SANITARY ENGINEERING DIVISION

INDIANA STATE CLEARINGHOUSE
STATE PLANNING SERVICES AGENCY
143 WEST MARKET ST. SUITE 300
INDIANAPOLIS, IN 46204
317/232-1470

Applicant's Name	Contact Person/Phone No.	County
U.S. Dept. of Energy, Div. of Natural Gas	Lynne H. Church, Dir.	Nation

treet Address	City, State, Zip
	Washington, D.C. 20461

RECEIVED
JUL 24 1980

rogram No./Fed. Funding Agency	Title
DOE	D.E.I.S.

PROJECT DESCRIPTION

DEIS: Regulatory Analysis for Review & Establishment of Natural Gas Curtailment Priorities

Area of Project Impact	Proposed Funding (Federal Share)
Nation	

	YES	NO	COMMENTS
Our agency is interested in this project.		x	
Meeting desired with applicant.		x	
s this project consistent with goals and objectives of your agency?			N.A.
s there evidence of overlapping or duplication with other agencies?			N.A.
Does your agency have a favorable review of attached application?			N.A.

Reviewer's Signature	Telephone No.	Date Signed
R.H. [signature], A.H.		7-21-80

STATE CLEARINGHOUSE ACTION

Clearinghouse Coordinator's Signature	Date Signed
Elizabeth Eaglesfield	7-24-80

JFA

DISTRIBUTION: White: Applicant, Canary: Reviewing Agency, Pink: Clearinghouse, White: Clearinghouse

STATE OF IOWA

Office for Planning and Programming

523 East 12th Street, Des Moines, Iowa 50319   Telephone 515/281-3711

ROBERT D. RAY
Governor

ROBERT F. TYSON
Director

STATE CLEARINGHOUSE

PROJECT NOTIFICATION AND REVIEW SIGNOFF

te Received: July 8, 1980   State Application Identifier: 810073

Review Completed: August 6, 1980

PPLICANT PROJECT TITLE:
egulatory Analysis for Review and Establishment of Natural Gas Curtailment Priorities

PPLICANT AGENCY: U.S. Department of Energy   Washington, D. C. 20461
Address   Economic Regulatory Administration
Office of Regulations and Emergency Planning

DERAL PROGRAM TITLE, AGENCY   Priorities and Allocations for Energy Programs and Projects
D CATALOG NUMBER: Department of Energy
Economic Regulatory Administration
Catalog No. 81.048

OUNT OF FUNDS REQUESTED:
NA

OJECT DESCRIPTION:
gulatory Analysis for Review and Establishment of Natural Gas Curtailment Priorities.
E/RG-0026/1

e State Clearinghouse makes the following disposition concerning this application:

[X] No Comment Necessary. The application must be submitted as received by the Clearinghouse with this form attached as evidence that the required review has been performed.

[ ] Comments are Attached. The application must be submitted with this form plus the attached comments as evidence that the required review has been performed.

ATE CLEARINGHOUSE COMMENTS:

-14 Rev. 9-75

A. Thomas Wallace, Jr.
Federal Funds Coordinator
JFA

as they provide protection to users in priorities 1, 2 and 3.

Further, United's settlement provides that, if supply conditions fall below a certain floor, United is required to file a new plan under section 4 of the Natural Gas Act. The reason for that provision is that, if those supply conditions occur, it may be necessary to change the volumetric allocation of gas between markets to take account of the new circumstances. The ERA rule should not preclude United from filing a plan which contains an allocation mechanism appropriate to its system and to the supply conditions at that time.

V. Environmental Impact Statement.

Louisiana has an acute concern for the environmental impact of natural gas curtailment for two reasons: first, as the EIS shows, Louisiana's economy is extremely gas dependent. Natural gas curtailment policies therefore affect Louisiana proportionately more than they affect other regions of the country. Second, large portions of Louisiana have been identified by the Environmental Protection Agency as non-attainment areas which do not meet federal air quality standards.[8/] Heavy curtailment of Louisiana's industries will make a bad situation worse. Both of these facts should be considered in determining the environmental impact of curtailment changes which affect United. Louisiana agrees that considerations which are specific to particular regions can best be addressed at the time the FERC devises the allocation mechanism

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8 BNA Environmental Reporter 121:0964-65 (May 23, 1980).

to implement the ERA rule. That is true, however, only on the assumption that FERC retains and will exercise the discretion to devise the best allocation mechanism for a pipeline and its region. If, on the other hand, the ERA rule were intended to impose a single "rule of thumb" allocation mechanism or to preclude FERC from considering the distinctions between partial and full requirements customers when it implements the priorities established by ERA, the environmental effects of that decision on Louisiana should be specifically considered at this time. The existing EIS is inadequate to analyze the environmental impact of such an allocation mechanism because the EIS does not consider the effects of a curtailment program which will result in the curtailment of higher priority customers in one region for the benefit of lower priority customers in another.

Respectfully submitted,

Honorable David C. Treen
Governor, State of Louisiana

Honorable William J. Guste, Jr.
Attorney General, State of Louisiana

Honorable Frank A. Ashby, Jr.
Secretary, Department of Natural Resources, State of Louisiana

Honorable Ray T. Sutton
Commissioner of Conservation, State of Louisiana

David B. Robinson
Patton, Boggs & Blow
2550 M Street, N.W.
Washington, D. C. 20037

Attorney for the State of Louisiana

MARYLAND
DEPARTMENT OF STATE PLANNING
301 W. PRESTON STREET
BALTIMORE, MARYLAND 21201

HARRY HUGHES
GOVERNOR

CONSTANCE LIEDER
SECRETARY

August 11, 1980

Ms. Lynne H. Church, Director
Division of Natural Gas
Department of Energy
Washington, D.C. 20461

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT (EIS) REVIEW

Applicant: U.S. Department of Energy

Project: Draft EIS - Analysis of Natural Gas Curtailment Priorities DOE #0065

State Clearinghouse Control Number: 81-7-14

State Clearinghouse Contact: James McConnaughhay (383-2467)

Dear Ms. Church:

The State Clearinghouse has reviewed the above project. In accordance with the procedures established by the Office of Management and Budget Circular A-95, the State Clearinghouse received comments from the Department of Economic and Community Development, Department of Transportation, People's Counsel to the Public Service Commission and our staff noting that the statement appears to adequately cover those areas of interest to their agencies.

The State of Maryland appreciates this opportunity to review the draft statement and looks forward to continued cooperation with your agency.

Sincerely,

J. W. McConnaughhay

James W. McConnaughhay
Director, State Clearinghouse

cc: Henry Silbermann
Max Eisenberg
Thomas Hatem
John Keane
Lowell Frederick
Clyde Pyers

JMc:BG:pm

TELEPHONE: 301-383-2467
OFFICE OF STATE CLEARINGHOUSE

JFA

State of Missouri
OFFICE OF ADMINISTRATION
P.O. Box 809
Jefferson City 65102

Joseph P. Teasdale
Governor

William D. Dye, Director
Division of Budget and Planning

July 30, 1980

Mr. Lynne H. Church
Director
Division of Natural Gas
Department of Energy
Washington, D. C. 20461

Dear Mr. Church:

Subject: 80070059 (DOE/EIS-0065)

The Division of Budget and Planning, as the designated State Clearinghouse, has coordinated a review of the above referred draft environmental impact statement with various concerned or affected state agencies pursuant to Section 102(2)(c) of the National Environmental Policy Act.

None of the state agencies involved in the review had comments or recommendations to offer at this time.

We appreciate the opportunity to review the statement and anticipate receiving the final environmental impact statement when prepared.

Sincerely,

Lois Pohl

Lois Pohl
Chief, Grants Coordination

STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT
ENERGY RESOURCE AND DEVELOPMENT DIVISION

BRUCE KING
GOVERNOR

LARRY KEHOE
SECRETARY

POST OFFICE BOX 2770
113 WASHINGTON AVENUE
SANTA FE, NEW MEXICO 87501
(505) 827-2471

September 11, 1980

Betsy Reed
State Planning Division
Department of Finance &
Administration
505 Don Gaspar Avenue
Santa Fe, NM 87503

Dear Ms. Reed:

Thank you for providing us with the opportunity to review and comment on the U.S. Department of Energy's Regulatory Analysis, for Review and Establishment of Natural Gas Curtailment Priorities, Volumes 1, 2, 3 and 4, May 1980.

In view of the many and complex issues involved in assessing natural gas curtailment priority systems, the present study does an excellent job in presenting, analyzing and evaluating the most important approaches, which are in place or have been under consideration. As the study indicates, avoidance of significant costs or inequities in changing curtailment priority plans, necessitates (at the least) careful consideration of the user's application of gas, the amount of fuel substitution in place and the level of imbalance in demand and supply in the system. Enforcing uniform national curtailment plans is most likely to increase costs, as system differences (e.g. New Mexico's) require curtailments to be fitted to specific situations. Consequently, while efficiency-related modifications to the present system are always possible, substantial changes in curtailment priority systems should not be introduced if they cannot be proven to be administratively feasible,lead to significant shortage cost reductions, and provide the natural gas industry and users with greater certainty with respect to long-term curtailment policies.

Sincerely,

GEDI CIBAS, Ph.D.
Senior Energy Consultant

GC/cdm

Enclosure

North Carolina Department of Natural Resources & Community Development

James B. Hunt, Jr., Governor Howard N. Lee, Secretary

OFFICE OF REGULATORY RELATIONS

Anne Taylor
Director

Box 27687, Raleigh 27611
Telephone 919 733-6376

MEMORANDUM

To: Chrys Baggett, Director
State Clearinghouse

From: Bill Flournoy
Environmental Assessment Section

Re: E-81-5001

Date August 1, 1980

The Department of Natural Resources and Community Development has reviewed the subject document.

The Division of Environmental Management requests that at a minimum, State and local agencies should be informed when shortages are anticipated for SO_2 or particulate non-attainment areas.

WLF:esp

The State of North Dakota
FEDERAL AID COORDINATOR OFFICE
State Capitol
Bismarck, North Dakota 58505

(701) 224-2080

Wayne G. Sanstead, Lieutenant Governor
FEDERAL AID COORDINATOR

Arthur A. Link
GOVERNOR

August 5, 1980

"LETTER OF CLEARANCE" IN CONFORMANCE WITH OMB CIRCULAR NO. A-95

To: US Department of Energy

STATE APPLICATION IDENTIFIER: 8007079645

Mr. Albert F. Bass
Department of Energy
1000 M Street, NW
Room 7108
Washington, DC 20461

Dear Mr. Bass:

Subject: Draft Environmental Impact Statement for the Regulatory Analysis for Review and Establishment of Natural Gas Curtailment Priorities.

This Draft EIS was received in this office on July 7, 1980.

Thank you for submitting your draft environmental impact statement for review and comment through the North Dakota State Intergovernmental Clearinghouse.

Your draft was referred to the appropriate agencies, and no comments were received to this date.

Please send me copies of the final environmental impact statement and any supplemental impact statements to the North Dakota agencies that have commented on the draft, and to this office. The opportunity to review your draft is appreciated, and if this office as Clearinghouse can be of further assistance with this project, please let me know.

Sincerely yours,

Bonnie A. Banks gd

Mrs. Leonard E. Banks
Coordinator
State Intergovernmental Clearinghouse

1 AUG 80 10: 01

REC'D DOE/ERA

BAB/gd

State Intergovernmental Clearinghouse 224-2098 | State & Local Planning 224-2818 | Energy Management & Conservation 224-2250 | Community Action Assis 224-24

STATE CLEARINGHOUSE

30 EAST BROAD STREET • 39TH FLOOR • COLUMBUS, OHIO 43215 • 614 / 466-7461

80-08-22 P
09

Mr. Albert F. Bass
Department of Energy
2000 M Street, N.W.
Room 7108
Washington, D.C. 20461

RE: Review of Environmental Impact Statement/Assessment
Title: Draft EIS-For Review and Establishment of Natural Gas Curtailment Priorities. Volume #3, Statewide, 80-08, 12 Months
SAI Number: 36-471-0009

Dear Mr. Bass:

The State Clearinghouse coordinated the review of the above referenced environmental impact statement/assessment.

This environmental report was reviewed by all interested State agencies. Reviewing agencies have not stated specific concerns relating to this report.

Thank you for the opportunity to review this statement/assessment.

Sincerely,

Judith Y. Brachman

Judith Y. Brachman
Administering Officer

JYB:rmr

cc: DNR, Mike Colvin
EPA, Mary Rhodes

VICTOR ATIYEH
GOVERNOR

Executive Department

155 COTTAGE STREET N.E., SALEM, OREGON 97310

August 13, 1980

Lynne H. Church
Director
Division of Natural Gas
Department of Energy
Washington, D.C. 20461

Regulatory Analysis for Review and Establishment of
Natural Gas Curtailment Priorities
PNRS 8007 4 540

Thank you for submitting your draft Environmental Impact Statement for State of Oregon review and comment.

Your draft was referred to the appropriate state agencies for review. The consensus among reviewing agencies was that the draft adequately described the environmental impact of your proposal.

We will expect to receive copies of the final statement as required by Council of Environmental Quality Guidelines.

Sincerely,

INTERGOVERNMENTAL RELATIONS DIVISION

Kay F. Wilcox

Kay Wilcox
A-95 Coordinator

KW:cb

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS

Department of Administration
STATEWIDE PLANNING PROGRAM
265 Melrose Street
Providence, Rhode Island 02907

August 5, 1980

Ms. Lynne H. Church
Director
Division of Natural Gas
U.S. Department of Energy
Washington, D.C. 20461

Dear Ms. Church:

This office, in its capacity of clearinghouse designate under OMB Circular Number A-95, Part II, has reviewed the Draft Environmental Impact Statement for Review and Establishment of Natural Gas Curtailment Priorities, May 1980.

The document was received for review on July 7, 1980 from your office.

The Technical Committee of the Office of State Planning was presented the staff findings as a result of the review along with the staff's recommendation at its meeting of August 1, 1980. The Committee finds that the document is in conformance with applicable state plans and conflicts with no other plans of which it is aware and therefore has no comment or objection.

We thank you for the opportunity to review this document.

Yours very truly,

Rene' J. Fontaine
A-95 Coordinator

RJF/sjc

Reference File: EIS-80-06

STATE PLANNING BUREAU
State Capitol
Pierre, South Dakota 57501
605/773-3661

SOUTH Dakota Office of
Executive Management

August 14, 1980

Albert F. Bass or Paula Daigneault
Department of Energy
2000 M Street, N.W.
Room 7108
Washington, DC 20461

RE: DOE/EIS-0065
SAI #EIS-010381
Review and Establishment of Natural Gas Curtailment Priorities

Dear Mr. Bass or Ms. Daigneault:

The State Clearinghouse has distributed for review the above stated drafted environmental impact statement. No comments were received in regard to this document, but thank you for the opportunity to review and comment.

Sincerely,

James R. Richardson

James R. Richardson
Commissioner
STATE PLANNING BUREAU

JRR:kah

NC
9-25

STATE OF UTAH
Scott M. Matheson
Governor
Kent Briggs
State Planning Coordinator

Division of Policy and Planning Coordination
Intergovernmental Relations Section
Lorayne Tempest, Associate State Planning Coordinator
124 State Capitol
Salt Lake City, Utah 84111
533-4981

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533-4983

September 19, 1980

U.S. Department of Energy
Economic Regulatory Administration
Office of Regulations & Emergency Planning
Washington D.C. 20585

SUBJECT: Regulatory Analysis for Review & Establishment of Natural Gas Curtailment Priorities. Volumes 1, 2, 3 and 4. (SAI #800711120)

Dear Sirs:

The Utah State Environmental Coordinating Committee has reviewed the information in Volumes 1, 2, 3 and 4, of the Regulatory Analysis for Review and Establishment of Natural Gas Curtailment Priorities.

The Committee offers no comment at this time.

Thank you for the opportunity to review this material.

Sincerely,

Jerry Kern
Jerry Kern
A-95 Coordinator

JK:ba

JFA