EPA-450/3-75-037
February 1975

REGIONAL EMISSION PROJECTION SYSTEM

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-450/3-75-037	2.	3. RECIPIENT'S ACCESSION NO. PB250680
4. TITLE AND SUBTITLE Regional Emission Projection System (REPS)		5. REPORT DATE February 1975
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Booz-Allen and Hamilton, Inc.		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Booz-Allen and Hamilton, Inc. 4733 Bethesda Avenue Bethesda, Maryland 20014		10. PROGRAM ELEMENT NO.
		11. CONTRACT GRANT NO. 68-02-1005 T. O. 5
12. SPONSORING AGENCY NAME AND ADDRESS U. S. Environmental Protection Agency Office of Air Quality Planning and Standards Research Triangle Park, North Carolina 27711		13. TYPE OF REPORT AND PERIOD COVERED Final Report
		14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

16. ABSTRACT

The Regional Emission Projection System (REPS) is a computerized air pollution emissions projection model to project emissions at the AQCR level. It combines national and regional economic forecasts with point and area source inventories from the National Emissions Data System (NEDS) to project air pollution emission levels for the five criteria pollutants, on an annual basis, from the present to the year 2000.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Computerized emission projection systems	Future emissions Emission forecasts Emission projections	

18. DISTRIBUTION STATEMENT Release Unlimited	19. SECURITY CLASS (This Report) Unclassified	21. NO. OF PAGES 137
	20. SECURITY CLASS (This page) Unclassified	22. PRICE 6.00

EPA Form 2220-1 (9-73)

ATTENTION

AS NOTED IN THE NTIS ANNOUNCEMENT, PORTIONS OF THIS REPORT ARE NOT LEGIBLE. HOWEVER, IT IS THE BEST REPRODUCTION AVAILABLE FROM THE COPY SENT TO NTIS.

Mr. Archibald A. MacQueen
Environmental Protection Agency
Office of Air Quality and Planning Standards
Research Triangle Park, NC 27711

EPA-450/3-75-037

REGIONAL EMISSION PROJECTION SYSTEM

by

Booz-Allen & Hamilton
Management Consultants
4733 Bethesda Avenue
Bethesda, Maryland 20014

Contract No. 68-02-1005

EPA Project Officer: John C. Bosch, Jr.

Prepared for

ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
Office of Air Quality Planning and Standards
Research Triangle Park, N. C. 27711

February 1975

1a

This report is issued by the Environmental Protection Agency to report technical data of interest to a limited number of readers. Copies are available free of charge to Federal employees, current contractors and grantees, and nonprofit organizations - as supplies permit - from the Air Pollution Technical Information Center, Environmental Protection Agency, Research Triangle Park, North Carolina 27711; or, for a fee, from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161.

This report was furnished to the Environmental Protection Agency by Booz-Allen & Hamilton, Bethesda, Maryland, in fulfillment of Contract No. 68-02-1005. The contents of this report are reproduced herein as received from Booz-Allen & Hamilton. The opinions, findings, and conclusions expressed are those of the author and not necessarily those of the Environmental Protection Agency. Mention of company or product names is not to be considered as an endorsement by the Environmental Protection Agency.

Publication No. EPA-450/3-75-037

TABLE OF CONTENTS

INDEX OF FIGURES

INDEX OF TABLES

I. REPS SYSTEM OVERVIEW

The Regional Emission Projection System (REPS) is a computerized air pollution emissions projection model, for use at the AQCR level to project annual emissions. It combines exogenous national and regional economic forecasts with point and area source emission inventories for Air Quality Control Regions (AQCRs) to project air pollution emissions levels for the five criteria pollutants on an annual basis, from the present to the year 2000. The projection methodology involves the following major steps:

- Determine regional growth factors for future years which reflect the expected change (positive or negative) in pollution-producing activity. Growth factors are determined from regional economic and demographic forecasts.

- Project present regional emission inventories to future years using these growth factors. The base year emission inventories are those of the National Emissions Data System (NEDS).

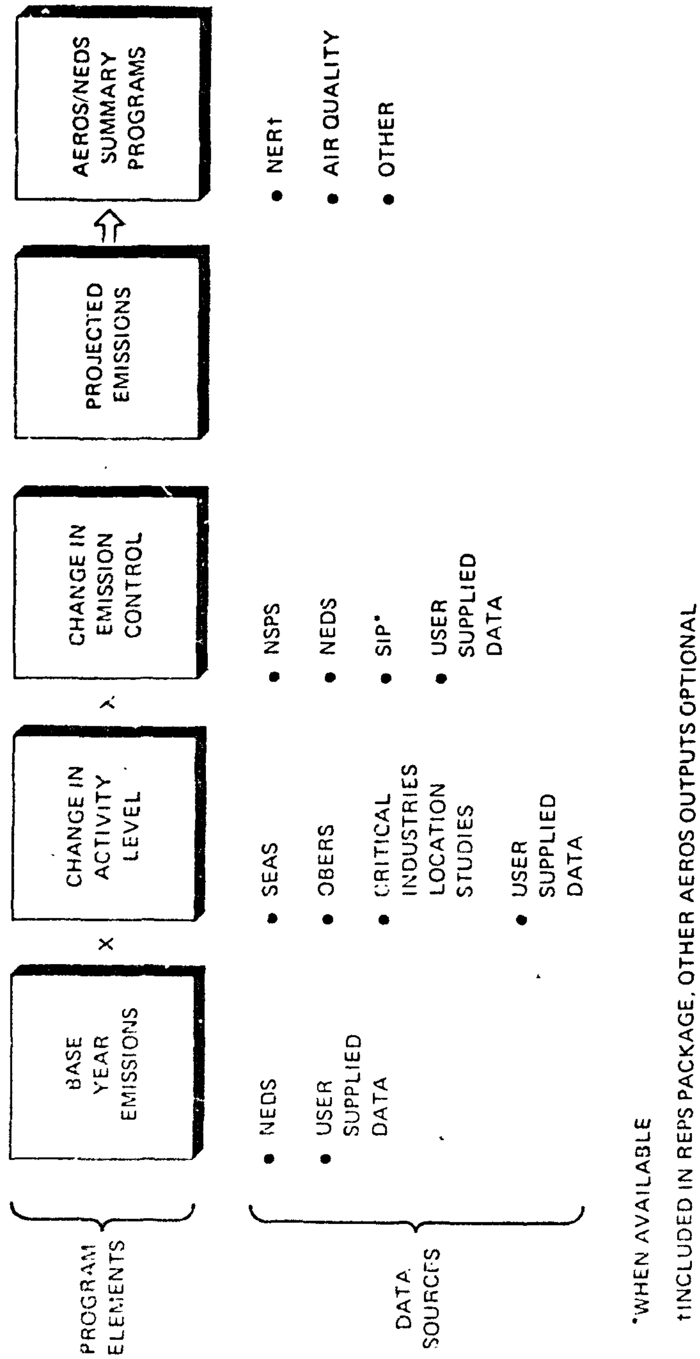
- Adjust the emission projections to include the effects of present and future control regulations. These include existing regulations from NEDS, and promulgated Federal standards (incorporated automatically by REPS) and state or local regulations (supplied by the user).

These three steps in the projection methodology correspond to the three basic elements of the REPS system. The general relationship among these elements and the sources of data used in each element are illustrated schematically in Figure I-1. As is indicated in the figure, the REPS system provides options for extensive user input to override the key parameters which determine the emission forecasts.

REPS can be used to project emissions for any of the 243 Air Quality Control Regions (AQCRs) and for the nation as a whole.* The

* The four AQCRs which include U.S. territories were not considered because regional economic projections were not available for them.

FIGURE I-1
REPS System Flow and Data Sources



base year to which all growth is referenced is selected by the user, and projections can be made for any year between 1974 and the year 2000. One execution of REPS produces emission projections for a single AQCR and a single projection year. At the present time the system is fully operational on the EPA's UNIVAC 1110 computer system at the Research Triangle Computing Center (RTCC), Research Triangle Park, North Carolina.

The three basic program elements of the REPS system:

- Calculation of Growth Factors from Economic and Demographic Forecasts
- Projection of Emission from Base Year Inventories
- Application of Emission Controls

are discussed in detail in the following sections. A more complete description of the scope and applicability of the REPS system, including discussion of:

- Outputs of the System
- Options for Users to Input Additional Data
- Potential Applications

is also given. These six sections provide a brief, but comprehensive, overview of the REPS system.

1. CALCULATION OF GROWTH FACTORS FROM ECONOMIC AND DEMOGRAPHIC FORECASTS

Regional economic and demographic forecasts are used in REPS to determine the expected change in the region's pollution producing activity. The fundamental postulate of this approach is that a change in pollution-producing activity is proportional to a change in purely economic and demographic parameters, such as total gross output, employment or population.

There are two primary sources for the economic and demographic forecast data used in REPS: EPA developed national economic growth projections, and Department of Commerce regional activity projections. National economic growth projections are taken from a standard output of the SEAS system,* and include total gross output for each of 284 economic sectors and subsectors. The SEAS projections are based on a sophisticated model of the national economy in which dynamic modeling of the inputs and outputs of each economic sector with respect to all other sectors is used to project the total gross output of each sector. These econometric projections for each sector are modified in the SEAS system to reflect additional factors which do not influence economic projections for specific industrial sectors, but which do have a substantial effect on emissions. These factors include future process changes and materials substitution, and disaggregation of selected sectors to account for industrial processes within one sector which may grow at different rates.

For each region, the relative share of the SEAS national output forecasts is established using the OBERS economic projections† for AQCRs, which contain regional forecasts of population and employment, in addition to projections of regional earnings for 28 industrial sectors. The OBERS projections are reviewed and updated regularly by the Department of Commerce. The methodology used in preparing the OBERS projections involves two basic steps. First, the economic growth of each sector was projected at the national level. Then these national totals were distributed regionally in accordance with historic and projected trends in the regional distributions of economic activity, tempered by available industry- and region-specific growth information.

The SEAS and OBERS projections have been supplemented in REPS by a special analysis of growth and relocation trends for five industries which are among the heaviest industrial polluters. These critical industries include electric power generation, steel, chemicals, pulp manufacturing and petroleum refining. The output of this analysis is a file of data on new plants expected to become operational in the future. For each plant, the SCC‡ Code, the AQCR, the projected startup year and the plant capacity are given. These data may be input to the program at the user's option.

---

* Strategic Environmental Assessment System, an econometric and emission forecasting model developed by the Office of Research and Development, Environmental Protection Agency, Washington, D.C.

† Regional Economic Activity in the U.S., 1972 OBERS Projections, developed by the U.S. Departments of Commerce and Agriculture for the U.S. Water Resources Council.

‡ Source Classification Codes defined in NEDS.

To incorporate the economic and demographic forecast data into the REPS program, dimensionless growth factors, reflecting the change in economic and demographic parameters for the projection year relative to the base year, are computed. By determining the relationship between SCC processes and the SEAS and OBERS industrial sectors, regional growth factors for each specific SCC process are calculated in REPS.

2. PROJECTION OF EMISSION FROM BASE YEAR INVENTORIES

Regional emissions in the base year, to which the growth factors described above are applied, are taken from the point and area source inventories of the EPA's National Emission Data System (NEDS). The REPS model uses the following elements of the data contained in the NEDS point source inventory for each source:

- SCC process code
- Net annual emissions
- Control efficiency
- Emissions permitted by existing regulations and compliance to those regulations.

REPS also uses the data in the area source inventory which define the levels of area source emission-producing activity in the base year. This activity includes transportation, fuel combustion, evaporation and miscellaneous area sources. Appropriate growth factors are applied to the data in order to calculate emissions in the projection year. The REPS system has the advantage of building emissions projections on known activity and source data from NEDS. Clearly, the accuracy of the projected emissions will depend on the accuracy of NEDS in the base year. New activities and industrial sources entering the region and not now accounted for in NEDS will appear in the projections only if entered into REPS via user options.

An alternative to the above approach, which was considered but not adopted in developing REPS, would be to determine projected regional economic activity, and then to translate the projected activity (given in terms of either dollars or physical units) directly to projected emissions without using a base year emission inventory. Since regional economic projections usually provide no more than two or three digit SIC industrial detail (e.g., steel manufacturing), all industrial sectors would have to be disaggregated to the SCC process level (e.g., open hearth, BOF, etc.) to reflect the actual process mix of the region. This is necessary, of course, because of the wide variation in emission characteristics for different processes. Even if the projected regional process mix were determined, national average emission factors would have to be used to convert the regional economic process activity to projected emissions.

The REPS approach, on the other hand, uses the actual process mix in the base year, as given in the NEDS inventory, to define the process mix upon which the projections are based, rather than relying on disaggregating industrial sector data. In addition, the base year emission data entered in NEDS are provided by the polluting facilities and are often based on stack tests or local emission factors. To translate economic data to emissions with comparable accuracy would require knowledge of these local or plant-specific emission factors.

3. APPLICATION OF EMISSION CONTROLS

The final step of the REPS emission projection methodology is to adjust the projected emissions to include the effect of emission controls required for each type of source in the projection year. This is a very important consideration because control regulations may require a reduction in emissions that more than offsets the projected increase in activity. Thus net emissions may decrease over time in spite of expected increases in industrial activity.

The REPS system includes the effect of control regulations in two ways. First, if any point source has been granted a control variance which will have expired by the projection year, projected emissions are reduced to the level allowable under those regulations. Data on current controls are taken from the NEDS point source inventory. Second, Federal New Source Performance Standards which govern new and retrofit industrial equipment, are included in the REPS system. Standards already promulgated in the Federal Register are included, as well as proposed standards which are likely to be promulgated in the future may be input at the user's option. The proposed standards were supplied by the Emission Standards and Engineering Division of the EPA's Office of Air Quality Planning and Standards. The effect of New Source Performance Standards on future emission is determined in the REPS system by estimating the portion of projected activity which will involve equipment or facilities governed by these standards.

The emission control data noted above may be supplemented by accessing the State Implementation Plan file which is expected to be an operational element of the Aerometric and Emissions Reporting System (AEROS) in the near future. The REPS program is designed to accept these data as soon as they are available. This file will contain emission control regulations to be implemented as part of state programs to maintain acceptable ambient air quality. Additional emission controls required by state or local regulations may be supplied by the user. This point is discussed later in the system overview.

4. OUTPUTS OF THE SYSTEM

The output of the REPS system is in two forms. One is the projected point and area source emission inventory given in the standard format of the NEDS system. All of the NEDS summary reporting programs may, therefore, be executed against the projected inventory. One of these reporting programs is the NE11 program, which aggregates all emissions into the National Emission Report (NER) format. Also, air quality models which convert annual emission levels, as given in the emission inventory, directly to ambient air quality, may be used.

The other principal output of the REPS system is a printed summary of projection statistics and error messages which occurred during execution of the program. This printout is valuable both for interpreting the projection results, and interpreting any computer problems which may have occurred. This summary contains:

- Listing of user-supplied override data
- Assumptions and defaults exercised
- Base year and projected fuel mix
- Automobile emission factors for the projection year
- Other related projection data developed by the program.

Any errors encountered during program execution are also included in the output. Standard error messages include:

- Coding errors for user-supplied data

- Any inability of the program to locate reference data from mass storage files.

Diagnostic messages explaining the path followed during program execution to overcome these errors are included in the printout.

5. OPTIONS FOR USERS TO INPUT ADDITIONAL DATA

The REPS system is complete and autonomous to the extent that the program automatically accesses all the input data described previously to project a complete emission inventory. However, there is provision in the system for extensive user input and override capability. Override data supercedes or replaces those parameters calculated automatically by the system which are used to forecast changes in pollution-producing activity levels. The general categories of data which may be overriden include:

- All economic and demographic growth factors (SCC-specific)

- Projected fuel use and fuel mix

- Projected transportation activity.

In addition the user may enter new data into the system which supplements rather than overrides existing data. The user may specify local emission control regulations which are more stringent than Federal standards. The user may also input emissions inventory data for new point sources expected to be operational in the future but which are not already included in either the base year inventory or in the data on new facilities for the five critical industries read by the program at the option of the user.

6. POTENTIAL APPLICATIONS

The REPS system is a tool which may be used to support any program which involves estimating future emission levels. The primary goal of the REPS system design and development effort was to achieve maximum flexibility, as exemplified by the comprehensive capability of the system to accept user supplied data.

In particular the system may be used for the following applications:

- Projected emissions, aggregated by emission source category, may be used to identify the future major pollution source categories in a region

- The projected percent change in emissions from the base year may be determined for aggregated emission source categories

- Emissions may be projected for alternate regional growth scenarios to determine the sensitivity of the projections to estimated growth rates

- The projection scenario approach may also be used to evaluate alternate emission control strategies.

The system is particularly well suited to projecting the effect of alternative growth/control scenarios mentioned above because of the ease in modifying existing data or entering additional data into the model, and because of the relatively efficient operation of the REPS program from a computer systems standpoint. The flexibility which is characteristic of the REPS system maximizes its utility for the above applications and other potential uses.

II. EMISSION PROJECTION METHODOLOGY

The purpose of this chapter is to describe in detail the method used in the REPS system to develop emission projections. Familiarity with both the general framework of the projection system and the specific procedures used to project emissions for each category of emission sources is essential for useful implementation of the system. Factors which were considered in developing the general structure of the system are discussed below.

1. EVOLUTION OF THE FRAMEWORK OF THE PROJECTION SYSTEM

The objective of the REPS program was to develop a computerized model to project annual emissions for Air Quality Control Regions. Certain characteristics of the output of the system were defined at the outset of the project. These included:

- Projection of emissions at only one geographic level (AQCR)*
- Consideration of only the five criteria pollutants—particulates, SO_x, NO_x, hydrocarbons and carbon monoxide
- Projection of all emissions in terms of tons per calendar year
- Capability to generate projections for any year between 1974 and 2000
- Use of econometric forecasts as the basis for estimating future emission-producing activity.

There would be areas of potential inaccuracy inherent to any projection model developed according to these criteria. The AQCR

* The system was, however, designed to accommodate input data at a variety of different geographic levels (e.g., States, SMSAs).

is a sufficiently small geographic region that the absolute accuracy of any economic projections for AQCRs must be regarded with some caution. This is because it is extremely difficult to predict with confidence local economic migration which results in economic growth of one AQCR at the expense of neighboring AQCRs. Also, the industrial sectors or categories for which economic projections are given are usually defined on the basis of Standard Industrial Classification* (SIC) codes. Emissions, on the other hand, are usually categorized according to related emission processes or equipment, such as the EPA Source Classification Code. Therefore, the correspondence between economic sectors and emission source categories is not always straightforward. Lastly, activity levels for non-industrial source categories, such as commercial or residential fuel use and some modes of transportation, are not as directly related to purely economic indicators as industrial activity. (The method used to calculate appropriate growth factors for these sources is discussed later in this chapter.)

Although the general framework for REPS was specified by the EPA at the outset, the approach to be used in meeting these broad objectives had to be developed. Two basic approaches were considered originally. One of them involved using regional economic forecasts to project a present regional emission inventory to the future. The other approach involved determining projected regional economic activity and translating the projected activity directly to projected emissions without using the present emission inventory.

There are two significant disadvantages of the latter approach which precluded its use in REPS. First, economic projections providing the greatest industrial detail are typically given at the national level, not the regional level. Regional disaggregation of national forecasts would be required to determine projected regional economic activity. The accuracy of any such national projections would be degraded substantially by regional disaggregation below the state level. Second, economic projections typically provide detail at no better that the two or three digit SIC level, which is not sufficient to identify the mix of various industrial processes within an industrial sector for a given region. The process mix must be known to compute emissions with any degree of accuracy.

Consequently the first approach mentioned above was implemented in REPS. This approach, which was summarized in the preceding chapter, involves the following operations. Present regional emission levels

---

* Executive Office of the President, Office of Management and Budget, Standard Industrial Classification Manual, 1972.

are defined using a detailed emission inventory, and growth factors are developed for future years for each emission source category. These growth factors reflect the expected change in pollution-producing activity. Base year emissions and activity are multiplied by these growth factors to project future emissions, which are modified to reflect future emission control regulations. This method is the more accurate of the two considered for three reasons:

- The base year process mix, upon which the projections are based, is defined by the region's base year emission inventory. Although it is known that the NEDS inventory of emissions is not entirely accurate for some AQCRs, continuing efforts are being made to improve its accuracy and the potential for obtaining very precise base year emissions at some point in the near future through use of NEDS is high.

- The base year emissions for a given point source are often based on stack tests or local emission factors, and are more accurate than those which could be computed from regional economic activity and national average emission factors.

- Emissions may be forecast on a point source basis, rather than an aggregated source category basis. This is desirable because equivalent uncontrolled emissions (and hence equivalent pollution-producing activity) may be computed for each point source, provided the extent of emission control employed in the base year is known.

The last factor is especially critical because of wide variation among regions in control required for a given process or industry, and the wide variation among point sources within a region with respect to compliance with those regulations.

There are some disadvantages associated with the basic approach used in REPS and it is appropriate to review them briefly here. The most accurate procedure to use in forecasting emissions would be to project emission-producing activity, which in the case of industrial process emissions is plant throughput, for each point source. In the method used in REPS, uncontrolled emissions for each point source are assumed to be equivalent to throughput and are multiplied by the same growth factor that is used for all point sources related to the given industrial process. Clearly the accuracy of the projections will be influenced by this approximation. In addition, projecting the base year inventory to the future excludes the following kinds of developments from affecting the future process mix within a region:

- Change in the process mix for a given industry to reflect conversion from outdated or obsolete processes to more modern ones (e.g., conversion from open hearth furnaces to BOFs or electric arc furnaces in the steel industry)
- Introduction of new processes within an industry already present in the region
- Relocation of new industries into or away from the region.

If such data are known by the user, they may be input to REPS through the extensive user-input capability of the system. A final area for potential inaccuracy in the REPS projection method is the inability to allocate with precision that portion of projected activity governed by Federal New Source Performance Standards, which are often more stringent than regulations governing existing equipment. Uncertainty in the projected emissions can occur if an increase in activity is due to utilization of idle capacity rather than installation of new equipment. The method used in REPS to apply both new source and existing source regulations to the emission projections is also discussed later in this chapter.

The discussion in the preceding chapter dealt with the general framework of the REPS system. The following section describes in detail the four sources of input data actually used in REPS to develop the emission projections within this general framework, and the remaining sections present specific information on the methodology used and the assumptions made in projecting emissions for each source category.

2. SELECTION OF DATA SOURCES

Future emissions are projected by the REPS system based on four sources of input data:

- Economic and demographic forecast data from the SEAS system* and the OBERS projections†
- Base year emission inventories and related data from the EPA National Emissions Data System (NEDS)
- Growth and relocation trends for five heavily polluting industries
- Additional data supplied by the system user.

The three steps in the REPS projection methodology, as shown in Figure I-1 and discussed in Chapter I, are:

- Determining regional growth factors for pollution-producing activity
- Projecting present emission inventories to the future
- Adjusting the emission projections to include the effect of required emission controls.

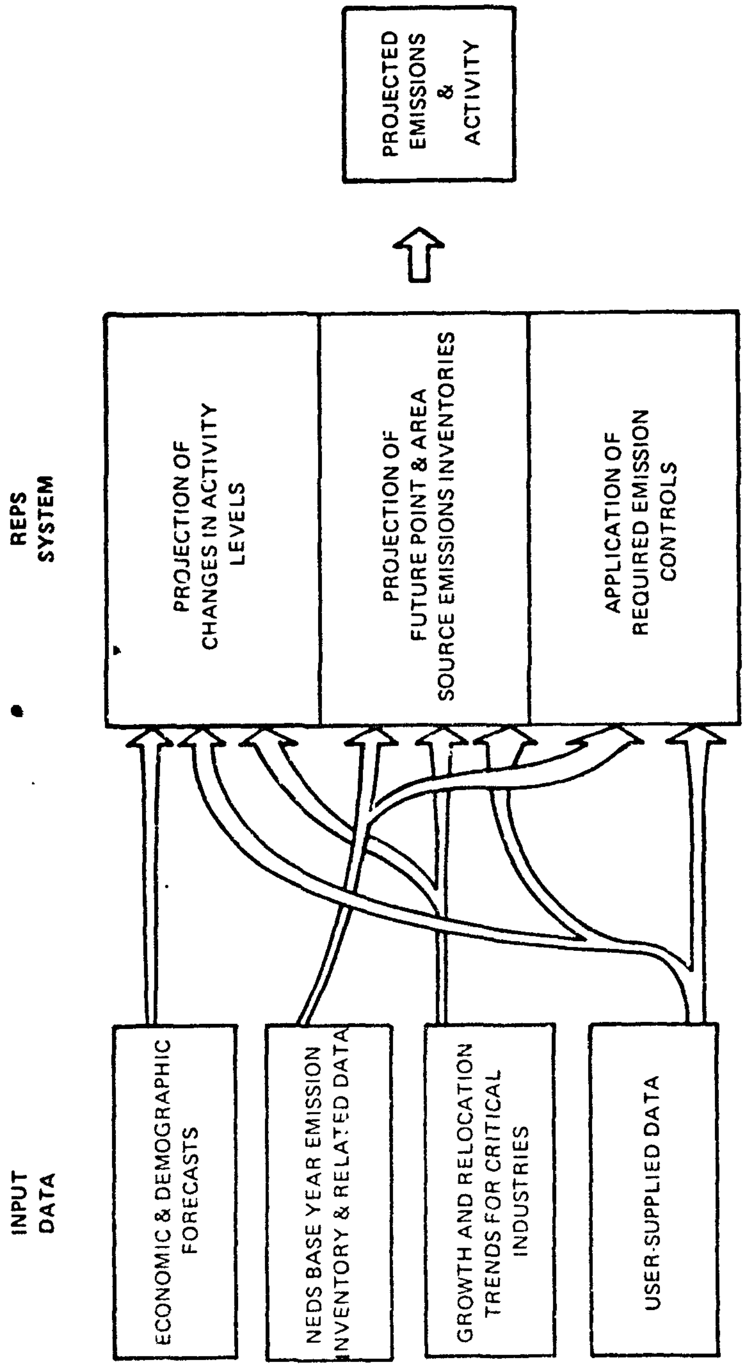
As indicated schematically in Figure II-1, the four data sources are combined to produce the output of the REPS system, projections of activity and emissions which include the effect of future emission control regulations. General observations concerning the selection of

---

* Environmental Protection Agency, Office of Research and Development, Prototype Development of the Strategic Environmental Assessment System (SEAS), April 1974, Draft.

† U.S. Department of Commerce, Bureau of Economic Analysis, Projections of Economic Activity for Air Quality Control Regions (OBERS Projections), August 1973.

FIGURE II-1
REPS Functional Elements



the SEAS and OBERS projection data, and the NEDS inventory for use in REPS are given below. Development of the growth and relocation trends for five critical industries and identification of the data which may be supplied by the user are topics discussed later in this chapter.

(1) SEAS Projection Data

The projections of national industrial growth by sector, as developed by the SEAS system, were used for a number of reasons:

- The data are obtained from a sophisticated and widely accepted input-output model of the national economy and the accuracy of the projections was, therefore, felt to be relatively high.

- Substantial industrial detail is available because 284 economic sectors are represented in the econometric model.

- The SEAS data are especially valuable for projecting emissions because the SEAS system models the effects of materials and fuels substitution, technological innovations and industrial process changes. These factors are all critical for predicting future levels of emission-producing activity.

- The SEAS system was developed by EPA. Use of the SEAS projection data in REPS makes it possible to compare emission forecasts generated by two EPA models which utilize somewhat different methodologies.

The REPS system is designed to produce annual emission projections to the year 2000, while the last year for which SEAS projection data were available was 1985. Consequently, national growth for all industry sectors during the period 1985 to 2000 was assumed to be 3.8 percent per year, which has been the rate of real growth in GNP in the recent past.* Regional growth

---

* It is assumed that the recent decline in real GNP is a transient phenomenon.

for all industrial sectors for this period would not necessarily be 3.8 percent per year since the OBERS data is used to compute the regional share of national growth. This assumption does not represent a substantial degradation in the accuracy of the projections for the years 1985 to 2000 because less confidence should also be placed in the other sources of forecast data for long-term projections.

(2) OBERS Projection Data

The OBERS regional economic projections were used to regionalize the SEAS forecasts. Although this approach involves several basic assumptions and certainly introduces some degree of error in the final results, it was adopted for two basic reasons:

- The OBERS projections, developed by the U.S. Department of Commerce, are based on extensive local data accumulated by the U.S. Government, some of which are confidential or proprietary and which are consequently not available in other projection models
- The OBERS tapes are one of the few sources of regional projection data available at the AQCR level directly.

The SEAS projections are given in terms of total gross output; the OBERS projections in terms of earnings. Both data are in terms of constant dollars, which eliminates the effects of inflation and permits real growth factors to be computed. In regionalizing the SEAS projections of gross output, a scaling factor from OBERS, based on projected growth in sector earnings, is used. Although the relationship between output and earnings will not necessarily be uniform throughout the country or even within an AQCR, it is felt that the assumption made here will not introduce any severe errors.

Also fundamental to the projection methodology is the assumption that the growth as computed from the SEAS and OBERS projection

---

Earnings, which comprise about 80% of personal income on an all-industry basis, are defined as the sum of wages, salaries, other labor income and proprietors' income. Because employees generally share proportionately with capital in the productivity gains of an industry, changes in earnings of employees tend to be proportional to changes in total production levels.

data is proportional to growth in pollution-production activity such as plant throughput. In addition, the REPS methodology is based on the assumption that relative prices of industrial products will remain static. This assumption may introduce error if the prices of exhaustible mineral and energy resources increase substantially relative to other industrial products, but it is difficult to estimate the magnitude of the error with any degree of confidence.

(3) NEDS Regional Emission Inventory and Related Data

The NEDS inventory contains the following types of data for point sources:

- Base year emissions
- Emissions permitted by existing regulations and compliance with these regulations
- Operating data for new plants expected to become operational in the future.

The area source inventory defines the levels of emission-producing area source activity; it does not contain emission data explicitly.

Two data sources related to the NEDS inventory are used by REPS in developing the emission projections. One is the compilation of emission factors as published in EPA document AP-42.* The other is a summary of Federal New Source Performance Standards (NSPS) which govern emissions from new and retrofit industrial equipment. This summary includes standards already promulgated in the Federal Register, as well as proposed standards which are likely to be promulgated in the future. The proposed standards were supplied by the Emission Standards and Engineering Division of the EPA's Office of Air Quality Planning and Standards, and are given following page II-35.

---

*The computer file containing the emission factors used by REPS is updated more often than document AP-42 and contains current emission factor data.

The NEDS system is used in REPS because it contains all the data required for projecting a complete emission inventory.* In addition to net base year emissions for existing point sources, it contains data concerning both base year emission regulations and future point sources, as defined previously. The data are referenced by AQCR, and the format of the data is uniform from region to region. Since the projections are produced in this data format, they are compatible with any of the NEDS/AEROS summary programs or air quality models.

Some characteristics of the NEDS system should be kept in mind when evaluating the emission projections developed by REPS. First, the projected emission inventories will be no more complete or accurate than the base year inventories from which they are developed. The extent to which the NEDS inventory is complete, accurate and timely is in many cases difficult to evaluate. The NEDS inventory for a given AQCR is considered in REPS to be accurate for calendar year 1974, even though the data may have been collected and submitted prior to that year. This was done primarily because all jurisdictions are required to update their inventories regularly, so that all data in the NEDS system are in principle timely and complete.

* * * *

The remainder of this chapter is devoted to a detailed description of all the sources of data mentioned previously, and a comprehensive explanation of how those data are used to develop projections of activity and emissions. This discussion is presented in three sections:

- The development of growth factors from economic and demographic forecast data
- The analysis of growth and relocation trends for the five critical industries
- The methodology for projection future emissions and activity and applying emission control regulations.

This discussion of the REPS methodology is followed by a summary of the method used to implement the projection model on the EPA's UNIVAC 1110 computer system, on which REPS is fully operational.

3. DEVELOPMENT OF REGIONAL GROWTH FACTORS

The regional growth factors computed from exogenous economic forecasts are used to estimate future activity and emissions. These growth factors reflect changes in economic activity levels forecast for the region, and are of three general types:

- Economic growth for industrial sectors containing groups of specific industrial processes
- Growth for aggregated groups of economic sectors (in terms of employment or earnings)
- Growth in population.

The above growth factors are computed from the two sources noted earlier:

- National economic growth projections developed by EPA using the SEAS projection system
- The OBERS regional activity projections published by the Department of Commerce.

The approach used in REPS to develop the industrial sector growth factors from SEAS and OBERS data is presented in detail below. That discussion is followed by a description of the method used to compute the growth factors both for population and for aggregated economic groups which are both computed from OBERS data exclusively.

(1) Industrial Sector Growth

The SEAS model of the national economy developed by EPA, and incorporating the econometric and input-output models created and maintained by the Bureau of Business and Economic Research at the University of Maryland, produces forecasts of total gross output (TGO) for each producing sector in constant dollars for each year between 1974 and 1985.* Since the sector

* Refer to SEAS documentation for a detailed description of this model.

TGO is expressed in constant dollars for all years, dimensionless growth factors reflecting change in sector TGO can be computed. Thus, the growth in sector TGO can be directly associated with changes in physical output. For those sectors which have been disaggregated, the subsector outputs are expressed in physical units from which the dimensionless national growth factor for the subsector can be computed. Sectors and subsectors in general are defined at the industry group (2- or 3-digit SIC) level. Of the 185 primary sectors and 99 subsectors, only 95 produce air pollution emissions and these are the only ones considered in the REPS system.

The SEAS projections of national total gross output used in the program are a standard output of the "base case" scenario. A sample page of SEAS output is shown in Figure II-2. For each sector, the data for 1974 are national and the data for later years correspond to the quantity (growth factor -1.00) No attempt to modify the SEAS projection data was made in REPS because the projections are felt to be of sufficient validity and accuracy for the purpose of the REPS system.

The SEAS projection data are processed by calculating for each sector and subsector the national growth factor for each projection year with respect to the base year (1974). For projection year t and base year t_o, national growth GN_a for SEAS sector a is given by

$$GN_a(t) = TGO_a(t)/TGO_a(t_o) \quad , \tag{1}$$

where TGO_a is the total gross output for sector a. The factor GN is always dimensionless since total gross output is defined in terms of either constant dollars or units of physical output.

The projections of national growth taken from SEAS are regionalized using the OBERS economic projections, which contain forecasts of regional growth in earnings for groups of sectors. The OBERS data are used to define the relative share of SEAS national growth by industry sector for each AQCR.

The OBERS projections contain forecasts of regional growth for groups of sectors. These projections were developed by the Office of Business Economics (OBE), presently the Bureau of Economic Analysis of the U.S. Department of Commerce, and the Economic Research Service (ERS) of the U.S. Department of Agriculture. The effort was initiated in 1964

FIGURE II-2
Sample SEAS System Output

SECTOR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
400	1633.54	0.04	0.07	0.10	0.13	0.15	0.18	0.18	0.19	0.20	0.22	0.23
902	8.26	0.06	0.12	0.18	0.23	0.29	0.36	0.41	0.45	0.51	0.56	0.62
903	0.98	0.06	0.12	0.17	0.21	0.26	0.31	0.34	0.36	0.39	0.43	0.47
1400	5210.09	0.04	0.09	0.12	0.16	0.19	0.22	0.22	0.22	0.21	0.21	0.21
1401	3048.31	0.06	0.13	0.19	0.23	0.28	0.34	0.38	0.40	0.44	0.48	0.52
1599	59075.04	0.06	0.11	0.16	0.21	0.27	0.32	0.37	0.40	0.44	0.48	0.52
1600	2739.42	0.05	0.11	0.15	0.16	0.22	0.26	0.29	0.31	0.34	0.36	0.40
1701	0.17	0.06	0.13	0.18	0.22	0.26	0.32	0.35	0.38	0.41	0.45	0.49
2300	30925.23	0.03	0.07	0.10	0.14	0.17	0.20	0.24	0.27	0.30	0.33	0.36
2400	14970.83	0.02	0.04	0.06	0.08	0.10	0.12	0.13	0.15	0.16	0.17	0.19
2600	13566.32	0.04	0.07	0.11	0.14	0.18	0.21	0.24	0.27	0.30	0.33	0.36
2801	8.27	0.03	0.06	0.09	0.13	0.16	0.20	0.22	0.25	0.27	0.30	0.32
2802	4.55	0.04	0.06	0.12	0.16	0.20	0.24	0.28	0.30	0.33	0.36	0.39
2900	4015.97	0.06	0.13	0.19	0.25	0.31	0.38	0.43	0.47	0.51	0.55	0.59
3000	13779.51	0.07	0.13	0.17	0.20	0.32	0.38	0.43	0.47	0.51	0.55	0.59
3300	6243.12	0.02	0.03	0.05	0.07	[illegible]	0.10	0.12	0.14	0.17	0.19	0.21
3599	59234.28	0.07	0.14	0.20	0.26	0.32	0.36	0.41	0.45	0.48	0.52	0.56
3600	3350.81	0.05	0.19	0.27	0.35	0.43	0.53	0.57	0.63	0.69	0.76	0.83
4100	10599.03	0.05	0.12	0.17	0.19	0.22	0.26	0.28	0.29	0.30	0.32	0.33
4300	5741.50	0.10	0.21	0.25	0.33	0.42	0.50	0.57	0.63	0.70	0.77	0.85
4597	12570.70	0.06	0.13	0.18	0.22	0.27	0.33	0.35	0.37	0.40	0.44	0.47
4700	1437.35	0.06	0.17	0.24	0.31	0.37	0.43	0.48	0.52	0.56	0.60	0.65
5500	22624.71	0.05	0.17	0.25	0.33	0.40	0.48	0.54	0.59	0.64	0.70	0.76
5501	12.49	0.08	0.17	0.25	0.22	0.40	0.49	0.54	0.59	0.65	0.71	0.77
5502	8.52	[illegible]	0.12	0.17	0.23	0.28	0.34	0.39	0.43	0.48	0.53	0.58
5505	[illegible]	0.08	0.17	0.24	0.31	0.38	0.46	0.51	0.55	0.60	0.65	0.71
5506	[illegible]	[illegible]	0.13	0.19	0.24	0.29	0.35	0.40	0.44	0.49	0.54	0.59
5507	[illegible]	0.06	0.12	0.18	0.23	0.29	0.36	0.41	0.45	0.51	0.56	0.62
5508	[illegible]	0.07	0.15	0.21	0.27	0.34	0.41	0.46	0.50	0.55	0.60	0.65
5900	[illegible]	0.05	0.11	0.17	0.22	0.28	0.34	0.39	0.44	0.49	0.54	0.60
6000	[illegible]	0.07	0.14	[illegible]	0.26	0.31	0.37	0.42	0.46	0.50	[illegible]	0.59
6100	[illegible]	0.05	0.10	0.14	0.17	0.21	0.25	0.27	0.29	0.31	0.34	0.36
6101	[illegible]	[illegible]	0.15	0.21	0.27	[illegible]	0.40	0.44	0.48	0.53	0.58	0.63
6299	[illegible]	0.13	0.27	0.41	0.55	0.69	0.85	0.99	1.11	1.25	1.40	1.55
6200	[illegible]	0.12	0.25	0.37	0.48	0.60	0.73	0.84	0.94	1.04	1.16	1.28
6399	[illegible]	0.07	0.14	0.20	0.26	0.32	0.38	0.42	0.45	0.50	0.54	0.59
6300	[illegible]	0.08	0.15	0.21	0.27	0.33	0.40	0.44	0.48	0.53	0.58	0.63
6400	[illegible]	0.05	0.09	0.13	0.16	0.19	0.23	0.23	0.24	0.25	0.27	0.28
6500	4127.56	0.11	0.22	0.32	0.42	0.52	0.62	0.68	0.75	0.83	0.90	0.98
6700	11493.03	0.06	0.15	0.23	0.30	0.38	0.46	0.52	0.57	0.63	0.69	0.76
6800	[illegible]	0.05	0.10	0.14	0.17	0.21	0.25	0.27	0.28	0.30	0.32	0.35
6900	[illegible]	0.06	0.12	0.17	0.22	0.27	0.33	0.38	0.41	0.45	0.50	0.54
7000	6171.27	0.06	0.12	0.16	0.21	0.26	0.31	0.34	0.37	0.40	0.43	0.46
7001	[illegible]	0.06	0.11	0.16	0.21	0.26	0.31	0.35	0.38	0.41	0.45	0.49
7100	[illegible]	0.06	0.17	0.24	0.30	0.38	0.47	0.53	0.59	0.66	0.73	0.81
7200	5924.01	0.07	0.15	0.21	0.28	0.35	0.42	0.47	0.52	0.58	0.63	0.69
7300	4727.72	0.07	0.13	0.18	0.23	0.27	0.32	0.34	0.36	0.39	0.42	0.45
7400	[illegible]	0.14	0.29	0.43	0.58	0.74	0.92	1.06	1.20	1.36	1.52	1.69
7599	6137.53	0.05	0.09	0.12	0.15	0.17	0.18	0.18	0.17	0.16	0.15	0.13
7800	6258.42	0.07	0.15	0.22	0.28	0.35	0.42	0.47	0.51	0.56	0.62	0.68
7900	1274.17	0.04	0.11	0.13	0.12	0.13	0.16	0.16	0.14	0.14	0.15	0.16
8099	5247.06	0.06	0.14	0.19	0.23	0.27	0.33	0.36	0.38	0.41	0.45	0.49
8100	3513.53	0.07	0.15	0.19	0.22	0.27	0.33	0.36	0.39	0.42	0.46	0.50
8200	4480.43	0.06	0.13	0.18	0.22	0.27	0.32	0.36	0.38	0.41	0.45	0.49
8201	0.59	0.06	0.13	0.18	0.22	0.26	0.32	0.35	0.38	0.41	0.45	0.49
8399	55545.82	0.05	0.10	0.13	0.14	0.17	0.20	0.21	0.21	0.22	0.23	0.25
8300	33219.03	0.04	0.07	0.09	0.10	0.12	0.14	0.14	0.13	0.13	0.13	0.14
8301	89.93	0.04	0.07	0.09	0.10	0.12	0.14	0.14	0.13	0.13	0.13	0.14
8330	89.53	0.04	0.07	0.10	0.11	0.12	0.14	0.14	0.13	0.13	0.14	0.14

FIGURE II-2 (Continued)

8321	0.40	-0.15	-0.28	-0.40	-0.50	-0.59	-0.66	-0.72	-0.77	-0.81	-0.85	-0.87
8322	27121.65	0.08	0.14	0.19	0.21	0.23	0.26	0.26	0.25	0.25	0.25	0.25
8323	6384.38	0.07	0.14	0.20	0.24	0.28	0.34	0.36	0.38	0.40	0.43	0.46
8324	4713.04	-0.24	-0.43	-0.58	-0.70	-0.79	-0.85	-0.89	-0.92	-0.95	-0.96	-0.97
8400	7215.74	0.16	0.13	0.17	0.19	0.22	0.27	0.27	0.27	0.27	0.29	0.31
8431	6712.17	0.02	0.01	-0.06	-0.20	-0.35	-0.51	-0.66	-0.78	-0.86	-0.92	-0.95
8500	640.25	0.06	0.12	0.16	0.20	0.24	0.29	0.31	0.32	0.34	0.37	0.40
8600	553.08	0.04	0.09	0.12	0.13	0.16	0.19	0.19	0.19	0.20	0.21	0.23
8700	8917.66	0.08	0.16	0.22	0.28	0.34	0.41	0.46	0.49	0.54	0.59	0.65
8731	9.81	0.08	0.16	0.22	0.27	0.32	0.39	0.42	0.43	0.45	0.47	0.48
8800	1224.50	0.07	0.14	0.18	0.22	0.26	0.30	0.31	0.32	0.32	0.34	0.36
8802	0.00	0.07	0.14	0.21	0.27	0.33	0.39	0.44	0.47	0.51	0.56	0.61
8806	0.00	0.07	0.14	0.21	0.27	0.33	0.40	0.44	0.47	0.51	0.56	0.63
8809	15.29	0.10	0.20	0.29	0.37	0.45	0.54	0.57	0.61	0.65	0.71	0.76
8811	0.03	0.04	0.08	0.11	0.12	0.14	0.16	0.16	0.16	0.16	0.17	0.18
8900	1129.82	0.07	0.14	0.19	0.22	0.25	0.30	0.31	0.31	0.32	0.33	0.35
9100	1075.46	0.06	0.15	0.22	0.27	0.33	0.40	0.44	0.48	0.51	0.56	0.61
9200	4699.96	0.05	0.10	0.15	0.20	0.25	0.30	0.34	0.37	0.41	0.45	0.49
9359	307855.91	0.07	0.15	0.21	0.26	0.32	0.38	0.42	0.45	0.49	0.54	0.59
10100	4898.55	0.07	0.14	0.20	0.25	0.31	0.37	0.40	0.43	0.47	0.51	0.55
16000	35463.26	0.07	0.13	0.20	0.26	0.33	0.40	0.45	0.50	0.55	0.60	0.66
16001	2854.71	0.06	0.11	0.14	0.20	0.24	0.26	0.26	0.25	0.24	0.23	0.21
16002	1016.99	0.11	0.20	0.28	0.38	0.46	0.52	0.55	0.55	0.56	0.56	0.55
16003	1285.01	0.01	-0.00	-0.02	-0.03	-0.04	-0.08	-0.12	-0.18	-0.23	-0.27	-0.32
16030	756.25	0.15	0.30	0.45	0.63	0.81	0.98	1.11	1.22	1.33	1.44	1.54
16031	2098.47	0.03	0.04	0.03	0.04	0.13	0.00	-0.04	-0.10	-0.16	-0.21	-0.27
16032	526.29	0.11	0.21	0.29	0.40	0.49	0.56	0.60	0.61	0.62	0.63	0.63
16033	490.71	0.10	0.19	0.26	0.35	0.42	0.47	0.49	0.49	0.48	0.48	0.46
16034	0.70	0.85	3.12	7.59	13.59	25.52	49.57	92.49	165.57	287.57	481.73	787.94
16035	357.11	0.25	0.69	1.66	2.07	2.77	3.87	5.10	6.36	7.63	8.77	9.81
16036	2.30	0.36	0.82	1.39	2.21	3.25	4.53	6.07	7.93	10.24	13.15	16.68
16037	1282.66	0.01	-0.00	-0.03	-0.03	-0.05	-0.09	-0.13	-0.19	-0.24	-0.30	-0.35
16038	357.81	0.25	0.89	1.68	2.09	2.82	3.96	5.27	6.67	8.17	9.69	11.33
16100	20105.92	0.03	0.06	0.09	0.12	0.15	0.19	0.22	0.25	0.29	0.33	0.37
16101	10137.86	0.06	0.12	0.17	0.22	0.27	0.33	0.37	0.40	0.43	0.47	0.51
16200	5279.12	0.04	0.05	0.07	0.09	0.12	0.15	0.17	0.20	0.23	0.26	0.29

and is sponsored by the United States Water Resources Council. Projections of population, employment and earnings have been developed by state, water resources area, 173 OBE economic areas, AQCR and SMSA. At the present time only OBERS data for AQCR's are used by REPS, so that regional emission projections are available only on an AQCR basis. However, the program was designed so that it can be readily adapted to produce projections for other geographic regions.

The OBERS projections were developed by the Commerce and Agriculture Departments by first projecting growth in the national economy and for each industrial sector on a national scale, and then distributing the national totals regionally in accordance with expected trends in the regional distributions of economic activities. The projection and regional allocation methodologies were based essentially on the extension of historical trends, modified by the inclusion of available industry- and regional-specific information.

The projection data includes regional population and employment, and regional earnings for 28 industrial groups defined mainly at a two-digit SIC level of detail. The earnings projections are given in terms of constant 1967 dollars. The OBERS projection data (earnings, population and employment) are given for the years 1970 to 2000 in 5-year increments as shown in Figure II-3. Before regional growth factors are calculated in REPS, two operations are performed on the OBERS data. These involve:

- Corrections for any data withheld from publication because of proprietary disclosures

- Linear interpolation for intervening years.

The procedure used to correct incomplete or missing data is described in more detail below.

Data are omitted from the OBERS projections whenever publication would result in the disclosure of confidential or proprietary information. In these cases either partial data are published and indicated as such, or the data are missing completely. Thus, the status of any element in the projection data could be either complete, partial or missing. Since data for

FIGURE II-3
Sample OBERS Output

A.O. AREA- SOUTH CENTRAL ALASKA
(A.O. CODE 010)

TABLE 1. POPULATION, EMPLOYMENT, PERSONAL INCOME, AND EARNINGS BY INDUSTRY, HISTORICAL AND PROJECTED, SELECTED YEARS, 1962 - 2000

	1962	1968	1969	1970	1975	1980	1985	1990	1995	2000
POPULATION, MIDYEAR	132,166	163,675	171,982	178,332	199,800	224,100	247,200	272,700	295,900	321,200
PER CAPITA INCOME (1967$)*	3,289	4,161	4,326	4,404	5,048	5,848	6,658	7,580	8,789	10,191
PER CAPITA INCOME RELATIVE (US=1.00)	1.27	1.25	1.26	1.27	1.26	1.23	1.23	1.23	1.23	1.23
TOTAL EMPLOYMENT						101,500	108,600	116,700	126,000	136,500
EMPLOYMENT/POPULATION RATIO	.00	.00				.45	.44	.43	.43	.43
				IN THOUSANDS OF 1967 $						
TOTAL PERSONAL INCOME *	434,709	681,047	741,899	784,511	1,008,600	1,310,700	1,646,000	2,067,100	2,601,300	3,273,700
TOTAL EARNINGS		636,088	656,860	730,540	924,200	1,169,200	1,446,300	[illegible]	2,222,700	2,761,600
AGRICULTURE, FORESTRY & FISHERIES		10,774	9,771	9,659	13,000	17,700	20,400	23,500	28,600	34,800
AGRICULTURE	>	4,511>	1,483>	289>	2,700	5,400	4,500	3,900	4,200	4,500
FORESTRY & FISHERIES	>	6,263>	8,288>	>	10,000	12,300	15,500	19,600	24,400	30,200
MINING		35,235	50,961	44,323	57,900	75,600	88,100	102,800	119,600	139,300
METAL	>	>	98>	>	(D)	(D)	(D)	(D)	(D)	(D)
COAL	>	619>	>	>	300	500	500	400	600	400
CRUDE PETROLEUM & NATURAL GAS		34,491	50,832	44,082	(D)	(D)	(D)	(D)	(D)	(D)
NONMETALLIC, EXCEPT FUELS	>	>	>	>	100	100	100	200	200	200
CONTRACT CONSTRUCTION		75,129	79,898	72,6?5	97,900	131,900	160,700	195,800	240,100	294,500
MANUFACTURING		25,581	29,720	36,636	37,800	39,000	45,100	52,000	61,700	73,100
FOOD & KINDRED PRODUCTS		16,734	17,251	22,615	20,100	17,800	18,600	19,400	20,400	21,500
TEXTILE MILL PRODUCTS		13	21	13						
APPAREL & OTHER FABRIC PRODUCTS	>	>	>	>	400	400	500	600	700	800
LUMBER PRODUCTS & FURNITURE		987	1,066	1,190	1,700	2,500	3,300	4,500	5,800	7,500
PRINTING & PUBLISHING	>	>	>	>	4,300	5,400	6,800	8,700	11,200	14,300
CHEMICALS & ALLIED PRODUCTS	>	>	>	>	3,500	4,600	5,800	7,300	9,300	11,900
PETROLEUM REFINING		568	643	1,054	900	800	900	1,100	1,200	1,400
FABRICATED METALS & ORDNANCE	>	>	156>	217>	300	400	600	800	1,100	1,700
MACHINERY, EXCLUDING ELECTRICAL	>	>	>	>	1,000	1,500	2,000	2,600	3,200	3,400
ELECTRICAL MACHINERY & SUPPLIES	>	>	26>	33>						
MOTOR VEHICLES & EQUIPMENT		39	37	42						
TRANS. EQUIP., EXCL. MTR. VEHS.		204	195	253	300	400	400	500	600	700
OTHER MANUFACTURING		2,748	3,279	4,0?1	4,300	4,700	5,500	6,300	7,400	8,800
TRANS., COMM., & PUBLIC UTILITIES		48,419	57,442	63,146	77,300	94,501	118,400	148,300	187,100	236,100
WHOLESALE & RETAIL TRADE		74,867	85,055	92,738	116,500	146,503	183,900	230,900	292,400	370,300
FINANCE, INSURANCE & REAL ESTATE		18,569	19,798	23,587	28,000	33,403	42,000	52,700	66,600	84,100
SERVICES		61,485	68,083	[illegible]	94,300	133,103	174,500	228,800	299,300	391,400
GOVERNMENT		284,510	296,131	313,686	[illegible]	497,100	612,200	753,900	925,900	1,137,400
CIVILIAN GOVERNMENT		170,2?7	180,464	192,612	255,800	339,700	427,200	537,200	672,500	842,000
ARMED FORCES		114,273	115,667	121,0?4	[illegible]	157,300	184,900	216,600	252,900	295,300

1962 DATA NOT AVAILABLE

Notes:

(D) Deleted to avoid disclosure of data pertaining to an individual establishment.

(*) Total and per capita income are expressed on a residence basis (income of residents in the area). Earnings all on a where-earned basis.

(>) Partial data to avoid disclosure of confidential information in component counties.

either the base year or future years could be affected, there were a total of nine possible situations resulting from the various combinations of data status (complete, partial or missing) and year (base or future). The processing logic of the program provides for each of these combinations with one of four corrective actions employed. The logical matrix for correcting incomplete data designed for use in REPS is given in Table II-1.

Table II-1
REPS Processing Logic for Incomplete
OBERS Input Data

Base Year Data	Projection Year Data	Corrective Action Taken by REPS
. Complete	. Complete	None
. Complete . Complete . Partial . Partial . Missing . Missing	. Partial . Incomplete . Partial . Missing . Partial . Missing	Assume shift in regional share is unity. This results in the INFORUM national growth factor being used for the regional growth factor.
. Partial	. Complete	Extrapolate base year value from projection data; use the extrapolated value or the given partial value for the base year, whichever is larger.
. Missing	. Complete	Extrapolate base year value from projection data.

Correcting partial or incomplete OBERS data for at least one industrial group was necessary for virtually every AQCR. Following correction for partial or missing data, linear interpolation was used to compute projection data for all intervening years which were not given specifically in the input data. This operation produced projection data for each year between 1974 and 2000.

The shift or change in regional share GS_b of national earnings for OBERS sector b is given by

$$GS_b(t) = \frac{E_b(t)/EN_b(t)}{E_b(t_o)/EN_b(t_o)} \tag{2}$$

where E_b is regional earnings for OBERS sector b and

$$EN_b(t) = \sum_{\substack{\text{all} \\ \text{AQCRs}}} E_b(t) \tag{3}$$

for any year t.

The regional share projections for industrial groups computed from OBERS data are combined with the projections of national industrial sector growth from SEAS data to produce the dimensionless regional growth factors used by REPS to forecast emissions. Since every point source in the NEDS emission inventory is identified by SCC code,* all regional growth factors were indexed in REPS by SCC code. This required the development of a matrix, or map, defining the correspondence among the 95 air pollution-producing SEAS sectors, the 28 OBERS industrial groups (both of which are SIC-oriented), and the approximately 1000 SCC codes. This correspondence was developed by identifying each SCC with the appropriate SIC. The resulting matrix is given in the AEROS program documentation of REPS program module NE055 (see Chapter III).

The regional growth factor GR_c for any SCC process c is computed by first determining the SEAS sector a and OBERS sector b corresponding to that SCC process, and then by computing

$$GR_c(t) = GN_a(t) \cdot GS_b(t) \tag{4}$$

---

*EPA Source Classification Code, which is oriented toward emission producing processes, rather than the economic and industrial relationships upon which the SIC system is based.

A set of regional growth factors were calculated in this manner for each AQCR. Each set contains growth factors for each SCC process in the AQCR, for each year from 1974 to 2000.

(2) Growth for Aggregated Economic Groups and Population

The process-specific growth factors discussed in the previous section are used in the REPS system to project point source emissions. Area source activity is projected using additional regional growth factors calculated in REPS from the OBERS projection data. These include growth in:

- Population
- Commercial/institutional employment
- Military employment
- Earnings for the entire industrial sector.

Regional population projections, based on Series C Census projections as of August 1973, were available directly from OBERS data. The method used to develop the other three types of growth factors is discussed in detail below.

Employment projections for the commercial/institutional and military sectors were developed by first forming ratios of national employment to national earnings for each projection year for these two sectors from published OBERS data. National employment forecasts for industrial groups are available from OBERS but not employment forecasts at the AQCR level. These national time-dependent ratios were then used to estimate regional employment based on projections of regional earnings for those sectors. If FS(t) and ES(t) are national employment and national earnings for year t for the commercial/institutional sector f and military sector g, and E(t) represents regional earnings for these two sectors, then the regional growth factor $GE(t_p)$ for commercial/institutional employment for year t_p relative to base year t_o is given by

$$GE(t_p) = \frac{\left[\dfrac{FS_f(t_p)}{ES_f(t_p)} \cdot E_f(t_p)\right]}{\left[\dfrac{FS_f(t_o)}{ES_f(t_o)} \cdot E_f(t_o)\right]} \qquad (5)$$

and the growth factor $GM(t_p)$ for military employment is given by

$$GM(t_p) = \frac{\left[\frac{FS_g(t_p)}{ES_g(t_p)} \cdot E_g(t_p)\right]}{\left[\frac{FS_g(t_o)}{ES_g(t_o)} \cdot E_g(t_o)\right]} \quad (6)$$

Employment and earnings data for the military sector are given explicitly in OBERS; employment or earnings for the commercial/institutional sector were computed as the sum of employment or earnings for the following OBERS sectors:

- Contract construction
- Wholesale and retail trade
- Finance, insurance and real estate
- Services
- Civilian government.

This approach is based on the assumption that regional ratios of employment to earnings will not differ significantly from the national ratios actually used. Clearly this assumption introduces some error into the calculation but it was not felt to be unreasonable.

A growth factor reflecting the expected change in overall industrial activity was computed from the OBERS earnings projections for the following sectors:

- Agriculture
- Mining
- Manufacturing
- Transportation, communications and public utilities.

The terminology used to represent these growth factors in the projection equations given later in this chapter are as follows:

- Population: GP(t)
- Commercial/institutional employment: GE(t)
- Military employment: GM(t)
- Overall industrial activity: GI(t)

The value of each of these growtn factors for year t is defined as (activity level for year t)/(activity level for the base year).

The application of these growth factors to the projection of emissions levels for area sources is described later in this chapter. In the following section an approach is described whereby data on specific regional growth trends for five critical industries were obtained. These results can be used in REPS to override the growth factors for these five sectors which are computed from SEAS and OBERS projections. In addition, the user has the option to override many of the growth factors computed automatically by REPS if more accurate local data are available. The specific details on user options are presented in Chapter III.

4. ANALYSIS OF GROWTH AND RELOCATION TRENDS FOR FIVE CRITICAL INDUSTRIES

The general forecast methodology employed in REPS involves projecting present regional emission inventories to future years based on economic forecast data. This approach produces emission projections which do not reflect directly the impact of:

- Relocation of new industries within the region
- Substantial expansion of activity at specific existing plants which exceeds that indicated by regional economic growth projections.

In either case, future emissions as predicted by REPS would be significantly understated.

There are two factors which indicate that the industrial composition of AQCR's with low current industrial concentration may be altered. These include:

- The relationship of AQCR boundaries to concentrations of industrial activities, and
- The barriers hindering location of new plants in areas of high industrial development and concentration, and their consequent location in sparsely settled areas that desire new development.

In many instances air quality control regions contain groups of counties of similar levels of economic development and consequently similar levels of ambient air quality. There are currently some AQCRs with high concentrations of heavily polluting activities and many with low concentrations. A gradual shift of future industrial development from areas with a high concentration of industry to adjacent areas with a lower concentration is a reasonable expectation, based upon the prevailing "central hub" theory of regional development. This pattern of future industrial development is encouraged by legal barriers impeding or preventing location of certain industries in areas with currently high industrial concentrations.

It can be expected that in some cases the SEAS and OBERS economic projections, in addition to defining incompletely the development of new industries within a region may fail to quantify precisely the expansion of certain existing industrial activities in the region to the detail necessary to develop accurate emission projections. This could be the result of migration of existing industries to sparsely developed AQCRs from neighboring AQCRs for the same reasons that new industries would choose to locate there. Alternatively, there is the possibility that the growth rate predicted by SEAS and OBERS data for a given industrial group (2-3 digit SIC level of detail) may be much less than the growth rate of one or more of the component industries of that group. This could happen when the earnings or total gross output of one industry relative to the entire industrial group is small, but the emissions of that industry are substantial.

If information concerning either relocation of new industries or significant expansion of existing facilities is available to the user, he may of course input those data to the system directly. Because such information may not be available to the user, however, the data base utilized by REPS was supplemented by an analysis of growth and relocation trends for five industries which are among the heaviest industrial polluters.

In general the purpose of this analysis was to assemble data on new plants expected to become operational in the future and on existing plants expected to increase their output significantly, in order to improve the accuracy of the data base used by REPS to project emissions. In particular the analysis focused on the following objectives:

- Identification of factors necessary for determining the location of new industrial point sources or expansion of activity at existing industrial plants within an AQCR

- Evaluation of alternative assumptions concerning future changes in the location of industrial activities that may be appropriate for AQCR-level emission projections

- Appraisal of the advantages and limitations of prospective techniques for determining possible industrial locational shifts

- Generation of specific new plant information, where possible, for selected industrial sectors.

There are three basic alternative methodologies for determining the potential for industry location:

- Statistical models
- Study of selected locational factors
- Company new plant announcements.

Each of these approaches is discussed briefly below:

- Statistical Models

  A review of statistical models of industry location indicates that reasonable projections can be obtained for long-term systematic shifts in economic activity where large numbers of economic units are involved, e.g., gasoline service stations. However, where small numbers of economic units are involved, the projections become highly uncertain with respect to the timing and the geographic location of new plants. For example, if an industry analysis of existing plant capacity and current and projected demand indicates the potential for 5 new plants over the next 10 years, projection of the year-to-year initial operation of these prospective plants would be highly speculative as would projection of the probable location of these plants within AQCRs.

  In addition, observed trends in the regional orientation of plants in the industry are used extensively in statistical models. While these trends reflect true historical development, they do not necessarily provide valid indications of future location of plants when only a small number of plants is concerned. For example, the fact that no new plants have been built in a region over a period of 10 years does not necessarily imply that none will be built there in the next 10 years. Therefore, analysis of historical trends in the location of industrial facilities appears to be irrelevant to the determination of the probable location of small numbers of plants.

- Study of Locational Factors

  Study of selected locational factors for particular industries can yield information concerning the influence of changes in the location of markets or resources upon costs. Individual companies evaluate these factors in the planning process, and information of this type is often the basis for investment plans and decisions relating to construction of new plants. Therefore, for the intermediate term of 3-5 years, new plant announcements and plant expansions would include the impact of locational factors.

For a longer term analysis (10-20 years), use of such information to postulate major shifts in industry location would, of necessity, rest on speculative grounds with respect to the timing of such shifts and the probable impact of such shifts upon the industry composition of particular AQCRs. Because of the large number of uncertainties implied in any such postulated shifts, particular scenarios have not been developed in this analysis, though the interface between REPS and exogenous new plant data, as described later in this section, can utilize such data.

- Company Announcements

The major advantages of utilizing company new plant announcements for identifying and incorporating possible industrial locational shifts in the emissions projection system include the fact that:

- Announcements are usually for specific types of activities at particular locations; therefore the pollution potential can be ascertained

- The impact of any changing locational factors will be (should be) weighted in the decision of the company.

The possible disadvantages and limitations of this type of information are that:

- Coverage may be inadequate due to unannounced expansions or new plants

- Plans for many announced plants are sometimes optimistic, and the plans may be postponed or cancelled

- Information is generally limited to 3-5 years in advance of operation

For the reasons indicated in the preceding discussion, neither statistical models nor a study of locational factors were used in this analysis to determine the potential for industry location; the methodology used was a review of company new plant announcements to identify future industry concentrations within relatively small areas.

Following the selection of an analysis methodology, the industries upon which the analysis would focus were identified. This was done based on nationwide annual emissions data for 1971 for the criteria pollutants, as given in unpublished data produced by the SEAS system. These data are summarized in Table II-2.

Table II-2
Rank of Heaviest Nationwide Polluting Industries

		1971 Sector Rank			
Inforum Sector	Part	SO_x	NO_x	CO	HC
Electric Generation	2	1	1	-	-
Steel	4	4	-	1	6
Industrial Chemicals, Plastics and Resins, Carbon Black	-	6	3	4	2
Pulp Manufacturing	6	-	-	3	3
Petroleum Refining and Heating Oil	11	5	2	2	1
Copper Smelting	7	2	-	-	-
Stone and Clay Manufacturing	1	-	-	-	-
Grains	3	-	-	-	-
Cement, Concrete and Gypsum	5	-	-	-	-
Zinc	-	3	-	-	-
Glass	-	-	4	-	-
Crude Petroleum and Natural Gas	-	-	-	-	5

Source: Unpublished data provided by EPA, Washington Research Center which was produced by the SEAS Test System as of February 1974. Scenario 1.

The first five industries listed in Table II-2:

- Electric generation
- Steel
- Chemicals, plastics and resins
- Pulp manufacturing
- Petroleum refining

were selected as the critical industries to which the case study analysis was directed. It can be seen from the table that these five industries are among the heaviest industrial polluters.

The major steps in collecting the data required for the analysis of each of these industries were as follows. First, the potential sources of data were identified following consultation with representatives of the Department of Commerce and trade associations. These sources included primarily trade publications and financial and economic papers. A comprehensive review of these data sources was then performed to accumulate company new plant announcements.

This effort identified a number of plant announcements; however, not all such data were included in the output of the analysis. The criteria for selection of plant announcements for inclusion in the REPS system were:

- The dollar value of the expansion was greater than $5 million
- Expansion as a percent of existing capacity was greater than 20 percent
- New equipment would not be replacing older equipment at the same location
- Sufficient location information was given to permit the AQCR involved to be identified
- The expansion was planned and announced with a high degree of certainty or confidence.

With respect to the last criteria, sufficient degree of certainty was indicated by one of the following conditions:

- Publication of a date for initial operation of the new equipment

- Announcement of contracts with engineering or construction firms

- Appropriation of funds approved by the firm's board of directors.

These conditions are listed in descending level of confidence. If the announcement indicated a lack of certainty in the proposal expansion, such as discussing only the conduct of engineering or feasibility studies, the proposed facility was not included in the output of the analysis. These selection criteria were used to screen the plant announcements in order to ensure that only the most probable industrial expansions would be included in REPS, and that those which were included would have more than a negligible effect on projected emissions.

It should be noted that if the plant announcement did not give the industrial capacity involved in the expansion, the capacity was estimated based on the dollar value of the appropriation. Also, in some cases the SCC code associated with the expansion could not be determined precisely from the announcement and consequently was established using the judgment of industry reports.

In general the output of the analysis of relocation trends for critical industries contains data for either specific new plants or expansions to specific existing facilities. The results of the analysis vary for the five industries considered, both in terms of the extent of industry coverage, reliability of the data, and the future period of time for which expansions were announced. A summary of the results for each industry are given below:

- Chemicals, Plastics and Resins

  New plant announcements identified a number of new plants and plant expansions associated with the rapid growth in the petrochemical, plastics and synthetic fiber industries.

Trade publications* follow these developments carefully based on company announcements and follow-up surveys. For inorganic chemicals related to fertilizer production, the Tennessee Valley Authority (TVA) is credited with careful analysis of new production capacity, though their publication, Fertilizer Trends, is of limited usefulness due to the long time lag between data collection and publication.

Locational shifts within the chemicals industry are not expected because of the economic advantages associated with major regions in which a number of chemical plants already exist. One exception is plants producing sulfuric acid, since a number of plants in the western states using smelter gases for acid production are expected to be closed.

The following limitations of using company announcements for determining the location of new chemical plants should be noted:

- Many plant expansions are not announced or reported in the trade press

- Many plants produce several chemicals, hence process identifications are sometimes very general

- Heavily polluting processes cannot be differentiated from those which produce lower levels of emissions

- Since the number of chemical-producing companies in any AQCR is sometimes small, data concerning plant capacity, investment plans, and type of process may be considered proprietary information

- Many plant expansions do not involve long lead-times so that most announcements concern only near-term plans

---

* Chemical and Engineering News, various issues, 1973-1974. Modern Plastics, Supply Status Reports 1, 2 and 3, May, June, July 1974. American Chemical Society, Chemistry in the Economy, 1973. Batelle Columbus Laboratories, Cost of Clean Air, 1974 (Appendix B).

- Steel

Company announcements* cover the plans of companies in this industry in great detail for a period of up to five years, particularly for the new mini-mills and the conversion from open-hearth to BOF furnaces.

For integrated iron and steel producing, however, no new U.S. mills have been announced despite the current and projected shortage in processing capacity.† Since announced expansion plans ordinarily do not significantly alter the share of production for any one region, no entries for this important segment of the steel industry were included in the output of the analysis.

- Petroleum Refining

Information concerning the location and probable timing of new petroleum refining capaci... is maintained by industry associations for their members.‡ The status of the plans and those of non-member firms are monitored by the Federal Energy Administration, which is the source of the data used in the analysis.§

---

* Iron Age, various issues, 1973-1974. Business Week, May 11, 1974-August 3, 1974. The Wall Street Journal, various issues. American Metals Market, various issues. Metals Weekly, various issues. Batelle Columbus Laboratories, Cost of Clean Air, 1974 (Appendix C).

† Business Week, May 11, 1974 and Paul Nelson, "The Booming Shortage of Primary Processing Capacity," in Challenge, Jan./Feb. 1974, pp. 45-48.

‡ Oil and Gas Journal, various issues, 1973-1974. American Petroleum Institute, Refining Capacity Added in 1973 and Publicly Announced Plans to Increase Refining Capacity in the U.S. for 1974-1977, press release.

§ Federal Energy Office, Trends in Refining Capacity and Utilization, June 1974.

- <u>Pulp Manufacturing</u>

  Investment plans for this industry are surveyed by trade associations. Plant and company information from these surveys are considered priorietary. However, a parallel survey is conducted by a trade publication.* This survey yielded data comparable to that compiled by the associations, and was the source of data for this analysis. Some of the SCCs associated with expansion of pulping activities were estimated, since information identifying the probable type of pulping process often is not provided and must be inferred from other information.

- <u>Electric Power Generation</u>

  The most extensive information for any of the industries studied is available for the location and type of new electric power generating plants. These data are collected by the Federal Power Commission from Regional Reliability Councils.† This information is based upon long-term plans of the electric utility companies for increasing generating capacity.

  The limitations of these forecasts are as follows:

  - Assumptions concerning the availability of nuclear power may be optimistic, thus leading to an understatement of the potential increase in fossil-fuel generating capacity.

  - Specific locations for some new plants have not been assigned; hence the AQCR involved cannot always be identified precisely.

---

* "Capital Spending," <u>Pulp and Paper</u>, January 1974.

† Federal Power Commission, <u>Electric Utility Expansion Plans</u>, News Release No. 20143, March 20, 1974. See also <u>Business Week</u>, May 11, 1974, and National Coal Association, <u>Steam Electric Plant Factors</u>, 1973.

- Potential new sources of fuel are not specified in the data.

- Fuel assignments for some plants are highly uncertain; in many cases, several fuels were listed as potential sources.

- In some cases only tentative information concerning the type of pollution controls was available.

- Data for plants under 300 MW capacity were not included.

Additional user-supplied data concerning forecasts of regional fuel availability, particularly the availability of low sulfur coal and oil, would enhance the REPS projections of emissions for electric generation.

The data developed on new plant locations for the five critical industries studied during the REPS development effort contain the following information for each specific plant or facility:

- Plant name and description
- SCC code
- AQCR
- NEDS plant identification code (if associated with an existing facility)
- Year in which the expanded facilities are expected to become operational
- Estimated annual capacity.

These data are input to REPS at the option of the user. The data and the format in which they must be coded for input to REPS are given in the program documentation in Chapter III. Before entering the data into REPS, however, the user must obtain the NEDS plant identification code for each existing plant in the AQCR for which critical industries' data are given.

The general method by which the critical industries data are input to the emission projection system is as follows. First the data are sorted so that only plant expansions which involve the AQCR under study, and which are expected to be operational by the projection year, are considered. Based on the plant identification code and the plant SCC, it is determined whether each plant for which expansion is indicated is already included in the base year NEDS inventory. If it is not, then a new point source record is created, and future emissions are estimated using the standard REPS projection methodology appropriate for the given source category. The growth factor used to project emissions is adjusted to reflect growth from the year in which the expanded facility will become operational, instead of from the normal base year (1974).

In the event that the expansion involves a plant included in the NEDS inventory, it must be determined whether the plant throughput as defined in the critical industries data exceeds the plant throughput as computed from the inventory data and the appropriate emission factor. The results of this comparison are independent of whether data for the year in which the expansion becomes operational or for the projection year are used; this is because the same SCC-specific growth factor is used to adjust the data from one source to the same year as the other source. The emissions entered in the projected inventory for the plant in question are computed from either the expansion data or NEDS, whichever indicates greater plant throughput. This assumption results in worst-case emission projections for the plant involved.

From the preceding discussion it can be seen that the plant-specific expansion data may have the effect both of enlarging the projected emission inventory, and of overriding the SEAS-OBERS growth factor for those plants for which expansions have been announced.

5. DESCRIPTION OF THE METHODOLOGY FOR PROJECTING FUTURE ACTIVITY AND EMISSIONS

In Section 3 a description of the method used to develop SCC-specific industrial growth factors and related economic growth factors was given. In this section the methodology used in REPS to project the base year emission inventory to the future using those growth factors, as well as future emission control requirements, is presented.

The REPS system projects future regional activity and emissions by applying dimensionless growth factors to base year activity and emissions as given in the NEDS point and area source emission inventory. The general procedure for projecting point source emissions in REPS is to compute projection data for each individual point source in order as contained in the inventory until the entire point source inventory in NEDS for the selected AQCR has been considered. Net emissions for the projection year, including the effect of future emission control regulations, are computed for all point sources.

The procedure for projecting area source emissions is to compute future area source activity for each record in the NEDS area source inventory. One NEDS area source data record ordinarily contains a summary of area source activity for a given county.* For area sources the output of the REPS system is projected activity, and not emissions, because the NEDS area source inventory does not contain emissions data explicitly. Area source emissions are computed in the NEDS system by NEDS/AEROS summary reporting programs such as NE11.

The REPS system does not include emissions controls for any area source category except gasoline highway vehicles. Regulations affecting emissions from these vehicles will have the ultimate effect of lowering the emission factors appropriate for future years. REPS, in addition to projecting activity for gasoline highway vehicles, computes weighted highway vehicle emission factors which reflect these regulations. These

* All NEDS area source data records are identified by AQCR; when REPS projects area source activity all area source records for the AQCR in question are processed. In the event that a given AQCR contains only a portion of a county, NEDS either contains an area source record for that portion, or the area source activity for that portion is included in the record for another county.

weighted emission factors are computed according to the method specified in document AP-42 (including Supplement No. 2), and include the effects of vehicle age and model year distribution. The weighted emission factors are based on national average data for projected composite emission factors and for the model year distributions given in Attachment No. 1 to AP-42.

Weighted emission factors for the projection year are used to compute future emissions from gasoline highway vehicles, and these emissions are included in the REPS printed output. Program NE11, on the other hand, when executed against the projected area source inventory, computes future emissions based on projected activity but using current vehicle emission factors. Consequently the projected gasoline vehicle emissions from the REPS printout should be substituted for the gasoline vehicle emissions in the NER or any other emissions summary.

There are two types of point source emission control regulations. One type, the New Source Performance Standards, governs only equipment installed after those regulations become effective. The other type governs all equipment, regardless of whether it was installed before or after promulgation of the standards. Typically new source standards are more stringent, because investment in new equipment justifies investment in pollution control. Control regulations may be promulgated at the Federal level or at the regional level (state or local). There are four specific classes of control regulations considered in the REPS system:

- Controls required in the base year, as reported by NEDS. A point source may, or may not, be in compliance with those requirements during the base year.

- Federal New Source Performance Standards (NSPS). Standards already promulgated in the Federal Register and standards expected to be promulgated in the future are included in the REPS data file. These data are summarized on the following page.

- Local new source performance and standards governing existing equipment, entered by the user.

State Implementation Plans (SIP) contain for many jurisdictions the most stringent of all applicable emission control regulations. At the present time SIP data defining required control efficiencies are not available in a computer file. The REPS system has the capability of automatically accessing SIP data when they become available. Until then, emission

Promulgated and Proposed Federal New Source Performance Standards

Source Category	SCC Code	Effective Year	Required Control Efficiency (%)				
			TSP	SO_x	NO_x	CO	HC
Steam Generators (Greater than 250 MBtu/hr)							
. Coal Fired	1-01-001-(01-02) 1-01-002-(01-05) 1-01-003-(01-06) 1-02-001-(01-02) 1-02-002-(01-05) 1-02-003-(01-06)	1975	98	90			
. Oil Fired	1-01-004-01 1-01-005-01 1-02-004-01 1-02-005-01 1-03-004-01 1-03-005-01	1975	98	70			
Nitric Acid Plants	3-01-013-(01-08)	1974			93		
Sulfuric Acid Plants	3-01-023-(01-18)	1974		96			
Sulfur Recovery Plants in Petroleum Refineries	3-01-032-(01-99)	1979		99.8			

Promuigated and Proposed Federal New Source Performance Standards
(Continued)

Source Category	SCC Code	Effective Year	Required Control Efficiency (%) TSP	SO_x	NO_x	CO	HC
Grain Handling	3-02-005-(01-04) 3-02-006-(01-99)	1978	99.6				
Primary Aluminum Ore Reduction							
. Bauxite Processing	3-03-000-01	1983	98				
. Calcinating	3-03-002-01						
Primary Copper Smelters (Roaster, Furnace, Converter)	3-03-005-(01-05)	1978		99.5			
Ferro-Alloy Production	3-03-006-(01-04) 3-03-006-05 3-03-007-01	1978 1978	99.7 99.7				
Iron and Steel Mills							
. Basic Oxygen Furnaces	3-03-009-03	1977	99.8				
. Electric Arc Furnaces	3-03-009-(04-05)	1977	97.4				
Primary Lead Smelters	3-03-010-(01-03)	1978	99.5				
Primary Zinc Smelters	3-03-030-(01-06)	1978	99.5	99.5			

Promulgated and Proposed Federal New Source Performance Standards
(Continued)

Source Category	SCC Code	Effective Year	Required Control Efficiency (%)				
			TSP	SO_x	NO_x	CO	HC
Secondary Brass and Bronze Refining (Reverberatory Furnaces)	3-04-002-(05-06)	1977	98.7				
Gray Iron Foundries	3-04-003-(01-02)	1983	99				95
Secondary Lead Smelters and Refineries	3-04-004-(01-04)	1977	97				
Asphalt Concrete Plants	3-05-002-(01-02)	1976	98				
Calcium Carbide	3-05-004-01	1978	99.7				
Coal Cleaning Plants							
. Thermal Dryers	3-05-010-(01-03)	1978	99				
. Air Tables	3-05-010-99	1978	90				
Gypsum Manufacturing	3-05-015-(01-04)	1983	99.8				
Petroleum Refineries							
. Process Gas Heaters	3-06-001-(01, 04)	1976		99			
. Catalytic Regenerators	3-06-002-01	1976	93				
	3-06-003-01	1976	93				

Promulgated and Proposed Federal New Source Performance Standards
(Continued)

Source Category	SCC Code	Effective Year	Required Control Efficiency (%)				
			TSP	SO_x	NO_x	CO	HC
Surface Coatings - Auto Assembly	4-02-(001,003-006,008-009)-01	1983					90
Municipal Incinerators (Greater than 50 tons/day)	5-01-001-01 5-02-001-01 5-03-001-01	1974	98				
Sewage Treatment Plants (Sludge Incinerators)	5-01-005-06	1976	99.6				

Source: Emission Standards and Engineering Division, EPA Office of Air Quality Planning and Standards control required by state or local regulations must be input to REPS by the user.

A fundamental element of the projection methodology is the procedure used to incorporate these future point source emission control requirements in the projection of emissions. Since new source standards affect the emissions of new equipment exclusively, the activity level of every point source during the projection year which is attributable to equipment governed by new source standards must be identified. This is done by allocating all positive growth in activity after the year the new standards become effective to new equipment, an approach which assumes that any increase in activity is due to new equipment and not to utilization of idle capacity.

The specific methodology for projecting activity and emissions is described in five sections which follow:

- Definition of terminology
- Point source industrial process emissions
- Point source emissions from stationary fuel combustion and solid waste disposal
- Transportation area source activity
- Area source activity for fuel combustion and solid waste disposal.

(1) Definition of Terminology

The following notations are used in the equations given in this chapter:

1. Subscripts

   - c: Source Classification Code (SCC)
   - d: Specific point source
   - i: Pollutant (point and area source)

- Particulates
- NO_x
- SO_x
- HC
- CO

j: Fuel (point and area sources)

- Anthracite coal
- Bituminous coal
- Lignite
- Residual oil
- Distillate oil
- Natural gas
- Process gas
- Coke
- Wood
- Liquid Petroleum gas
- Bagasse
- Solid waste with coal
- Diesel (stationary sources)
- Gasoline (stationary sources)
- Aircraft fuel (stationary sources)

k: Customer category for fuel use (point and area sources)

- External combustion, electric generation
- External combustion, industrial
- External combustion, commercial/institutional
- Internal combustion, electric generation
- Internal combustion, industrial
- Internal combustion, commercial/institutional
- Internal combustion, engine testing
- Solid waste disposal, government
- Solid waste disposal, commercial/institutional
- Solid waste disposal, industrial

- m: Road speed class for highway vehicles (area sources)
  - Limited access
  - Rural
  - Suburban
  - Urban

- n: Highway vehicle type (area sources)
  - Light-duty gasoline
  - Heavy-duty gasoline
  - Heavy-duty diesel

- p: Solid waste disposal method (area sources)
  - On-site incineration
  - Open burning
  - Sludge incineration
  - Auto body incineration
  - Rail car incineration

- q: Transportation source categories (excluding highway vehicles and aircraft) (area sources)
  - Off-highway vehicles, gasoline
  - Off-highway vehicles, diesel
  - Rail locomotives
  - Vessels, diesel
  - Vessels, residual oil
  - Vessels, bituminous coal
  - Vessels, gasoline

- r: Aircraft type (area sources)
  - Commercial
  - Civil
  - Military.

2. User Override Data

The value of any parameter designated with "*" may be overridden at the option of the user. If the user does not supply an override value, a default value is automatically calculated by the program. For example, GP*(t) is the population growth factor, which is used a number of times in developing the projections; the default value for this parameter is computed from the OBERS projections. If the user supplies an alternate value, that value is substituted every time the program references the population growth factor.

3. Exogenous User Data

Unlike the user override data described previously, these data do not override default values calculated by the program; these data supplement internally calculated data to provide the user with additional ways to input growth information to the program. If these exogenous data are not supplied. the program uses the standard or default procedures to project emissions. The data which can be input include:

$GV^*_m(t)$ = Growth factor for VMT of highway class m

$GFU^*_n(t)$ = Growth factor for highway vehicle fuel type

$RT^*_n(t)$ = Projected share of total VMT for highway vehicle type n

$GFV^*_q(t)$ = Growth factor for transportation source category q (excludes highway vehicles and aircraft)

$GFA^*_r(t)$ = Growth factor for aircraft type r

$PE^*(t)$ = Percentage of total residential space conditioning Btu demand satisfied by electricity

$RE^*(t)$ = Change in the fossil fuel residential Btu demand due to substitution of electricity.

4. Notations for Point Source Calculations

The following terms are used in the equations for projecting point source emissions. The terms refer to data for individual point sources.

- NEDS Inventory and Related Data: The follow- data are read from the NEDS emission inventory for each point source for the base year (t_o): the output projections are composed of data in the same format for the projection year (t_p).

  - $E_{di}(t)$ = net emissions for point source d and pollutant i
  - $AE_{di}(t)$ = allowable emissions for point source d and pollutant i
  - t_x = year in which the source will comply with allowable emissions
  - $C_{di}(t)$ = control efficiency for point source d and pollutant i
  - $A_{ij}(t)$ = emission factor (from NEDS emission factor file) for pollutant i and fuel j

- Growth Factors (SCC-specific)

  - $GR_c(t)$ = SCC-specific growth factor for year t corresponding to SCC process c, computed as discussed in the previous section

- Internally Developed Data

  - $EU_{di}(t_o)$ = uncontrolled base year emissions for point source d and pollutant i

- $EN_{di}(t)$ = future net emissions for point source d and pollutant i controlled by NSPS

- $ER_{di}(t_p)$ = future net emissions for point source d and pollutant i controlled by existing source standards

- $B_{dkj}(t)$ = Btu demand for a given point source d for fuel j within customer category k

- $BF_{kj}(t)$ = Btu demand for fuel j within customer category k (considering all point sources)

- $BC_k(t)$ = total Btu demand for customer category k

- $RF^*_{kj}(t)$ = fuel use ratio for fuel j within customer category k

- $GF_{kj}(t)$ = growth factor for fuel j within customer category k

- Emission Control Data

  - CN^*_i = control efficiency for pollutant i as required by NSPS

  - t^*_n = year in which NSPS become effective

  - CR^*_i = control efficiency for pollutant i as required by existing source standards.

5. Notations for Area Source Calculations

The following terms are used in the equations for projecting area source activity. Unless otherwise noted, the terms refer to activity data aggregated to the geographic level of NEDS area source records (usually the county level).

- NEDS Inventory and Related Data
  - $FA_{kj}(t)$ = area source fuel use for fuel j within customer category k
  - $SA_{kp}(t)$ = tonnage of area source solid waste disposal for disposal method p within customer category k
  - $FU_n(t)$ = fuel use for highway vehicle type n
  - $VMT_m(t)$ = measured vehicle miles travelled for road speed class m
  - $FV_q(t)$ = fuel use for off-highway vehicles, rail and vessels for source q
  - $LT_r(t)$ = landing-takeoff cycles (LTO) for aircraft type r
  - BTU_j = Btu content per unit fuel for fuel j
  - MG_n = average miles per gallon for highway vehicle type n
- Growth Factors
  - $GP^*(t)$ = population growth factor for year t

- $GE^{*}(t)$ = growth factor for commercial/institutional employment for year t

- $GM^{*}(t)$ = growth factor for military employment for year t

- $GI^{*}(t)$ = growth factor for total industrial activity for year t

- Internally Developed Data

  - $BA_{jk}(t)$ = Btu demand for fuel j within customer category k

  - $BD_{k}(t)$ = Btu demand for customer category k

  - $RA^{*}_{kj}(t)$ = Fuel use ratio for fuel j within customer category k

  - $SD_{k}(t)$ = Solid waste tonnage for customer category k

  - $RS^{*}_{kp}(t)$ = Solid waste disposal method ratio for method p within customer category k.

(2) Point Source Industrial Process Emissions

The methodology for projecting emissions from industrial process point sources involves the following general steps:

- Net base year emissions are first converted to uncontrolled emissions using the base year control efficiencies given in NEDS.

- SCC-specific growth factors are applied to the uncontrolled emissions to project future uncontrolled emissions. This is equivalent to assuming that changes in uncontrolled emissions are proportional to changes in plant activity as given by the growth factors.

- Uncontrolled future emissions are reduced to comply with emission control standards for the projection year.

Fundamental to this approach is the assumption that activity is proportional to uncontrolled emissions and hence that growth factors reflecting the expected change in activity levels can be applied to uncontrolled emissions.

Three types of required emission control which affect projected emissions are considered in REPS:

- Allowable emissions as reported by NEDS

- Federal NSPS and/or local standards governing new equipment (referred to as "new standards")

- Local standards governing existing equipment (referred to as "existing standards").

The general approach for projecting industrial process emissions involves developing the emission projections for each individual point source in sequence. The projection methodology is discussed in detail below.

The equations given in this section are applicable to each point source in the inventory. There are three alternate approaches used to project future emissions; the approach used for a given point source depends on the type of control information, if any, supplied by the user. The alternate approaches are:

- <u>No control standards given.</u>

  In this case, projected emissions for each point source d for pollutant i are given by:

$$E_{di}(t_p) = E_{di}(t_o) \cdot GR_c(t_p) \quad (7)$$

Where $GR_c(t_p)$ is the growth factor for the SCC "c" corresponding to the point source d in question. This is equivalent to assuming that the extent of emission control for the base year will be used for the projection year.

- Only new standards given.

Emissions governed by new standards are given by:

$$EN_{di}(t_p) = E_{di}(t_o) \cdot [GR_c(t_p) - GR_c(t_n)] \cdot (1 - CN_i)/(1 - C_{di}) \quad (8)$$

Emissions not governed by new standards, but controlled to the same extent as in the base year are given by:

$$ER_{di}(t_p) = E_{di}(t_o) \cdot GR_c(t_n) \quad (9)$$

Projected emissions are therefore:

$$E_{di}(t_p) = EN_{di}(t_p) + ER_{di}(t_p) \quad (10)$$

- Both new and existing standards given.

Emissions governed by new standards, $EN_{di}(t_p)$, are given by equation (8). Emissions governed by existing standards are given by:

$$ER_{di}(t_p) = E_{di}(t_o) \cdot GR_c(t_n) \cdot (1 - CR_i)/(1 - C_{di}) \quad (11)$$

and projected emissions are given by equation (10).

The last step in the projection sequence is to ensure that projected emissions do not exceed allowable emissions as given by NEDS. *If the projection year, t_p, is prior to the compliance* year, t_x, then the source is not required to be in compliance by the projection year and projected emissions need not be reduced. If the projection year is later than the compliance year, however, then it is assumed that the source will comply to the regulations and

$$E_{di}(t_p) = AE_{di} \qquad (12)$$

is substituted for the projected emission level if the projected emissions exceed the allowed level.

(3) Point Source Emissions from Stationary Fuel Combustion and Solid Waste Disposal

Emissions from point source fuel combustion, including electrical generation, are forecast by determining the projected Btu demand for each customer category, and then apportioning the Btu demand to the fuels expected to be used for that customer category to satisfy the projected Btu demand. Specifically, the projections involve the following steps:

- Net base year emissions for each point source are first converted to uncontrolled emissions using the base year control efficiencies, and then to fuel consumption using national average emission factors.
- The base year fuel use in equivalent Btus for each point source is computed based on average Btu content factor, which are incorporated directly in REPS.
- The future Btu demand for each point source is determined based on SCC-specific growth factors.
- The base year and projection year Btu demand for each customer category are determined by summing the base year and projected Btu demand for each point source within each customer category. (Customer categories are defined earlier in this section.)
- Growth factors for each fuel, for each customer category are computed based on base year and projection year Btu demand, and the fuel mix for the

projection year for each customer category. In the absence of user supplied fuel mix data, the base year fuel mix is used. These growth factors are then used to project the fuel use for each point source.

- Future net emissions are then computed based on the emission factors incorporated in NEDS and emission controls required during the projection year.

Emissions from solid waste disposal are computed in a similar way, except that the amount of solid waste burned, rather than the Btu demand, is determined for each customer category in the base year and projection year, and the projected tonnage is allocated to disposal methods in the same way that future fuel mix is used to allocate the projected Btu demand.

The equations which follow define the method for projecting fuel combustion emissions. The equations are valid for projecting emissions from solid waste disposal as well; in that case, subscript "k" refers to solid waste customer categories, and subscript "p" refers to disposal method. Uncontrolled base year emissions for pollutant i for each point source d are given by:

$$EU_{di}(t_o) = E_{di}(t_o)/(1 - C_{di}) \qquad (13)$$

Projected Btu demand for each point source d for year t_p can be computed from the uncontrolled emissions for only one pollutant using the emission factor A_i for pollutant i and Btu equivalent BTU_j for fuel j:

$$B_{dkj}(t_p) = EU_{di}(t_o) \cdot BTU_j \cdot GR_c(t_p)/A_{ij} \qquad (14)$$

for customer category k and fuel j, where $GR_c(t_p)$ is the growth factor for the SCC process "c" which corresponds to the point sources. The specific pollutant i for which data is used to compute the projected Btu demand is determined by selecting the first pollutant in ascending subscript order for which both base year emissions $E_{di}(t_o)$ and the emission factor A_{ij} are nonzero. For year t_p, the Btu demand for each fuel j within customer category k is computed from the Btu demand for each point source d within that customer category as

$$BF_{kj}(t_p) = \sum_d B_{dkj}(t_p) \tag{15}$$

The Btu demand for each customer category is

$$BC_k(t_p) = \sum_j BF_{kj}(t_p) \tag{16}$$

The base year fuel use ratio for fuel j within customer category k is equal to the Btu demand for fuel j divided by the Btu demand for the entire customer category k:

$$RF_{kj}(t_o) = BF_{kj}(t_o)/\sum_j BF_{kj}(t_o) = BF_{kj}(t_o)/BC_k(t_o) \tag{17}$$

Note that:

$$\sum_j RF_{kj}(t_o) = 1.0 \tag{18}$$

The growth factor for fuel j within customer category k is given by

$$GF_{kj}(t_p) = \frac{RF^*_{kj}(t_p)}{RF_{kj}(t_o)} \cdot \frac{BC_k(t_p)}{BC_k(t_o)} , \tag{19}$$

where $RF^*_{kj}(t_p)$ is the user supplied fuel mix for the projection year. This is equal to:

$$GF_{kj}(t_p) = RF^*_{kj}(t_p) \cdot BC_k(t_p)/BF_{kj}(t_o) \tag{20}$$

If the user does not supply $RF^*_{kj}(t_p)$, the base year fuel mix $RF_{kj}(t_o)$ is used and the growth factor becomes:

$$GF_{kj}(t_p) = \frac{BC_k(t_p)}{BC_k(t_o)} = \frac{\sum_j BF_{kj}(t_p)}{\sum_j BF_{kj}(t_o)} \tag{21}$$

If the user supplies some, but not all, of the projected fuel use ratios for a given customer category, then it is assumed that the fuels for which no ratios are supplied will be used in the base year proportions. In other words, if some $RF^*_{kj}(t_p)$ are given, then the remaining $RF_{kj}(t_p)$ are given by:

$$RF_{kj}(t_p) = \frac{RF_{kj}(t_o)}{\sum\limits_{\substack{j \text{ not} \\ \text{specified}}} RF_{kj}(t_o)} \cdot \left(1 - \sum_{\substack{j \text{ speci-} \\ \text{fied}}} RF^*_{kj}(t_p)\right) \qquad (22)$$

The preceding equations define the growth factor $GF_{kj}(t_p)$ which is used for each point source in the inventory, within customer category k, and burning fuel j. The method for applying this growth factor to the emissions data for each point source is identical with that given previously for industrial process emissions. That method involved:

- Multiplying uncontrolled base year emissions $EU_{di}(t_o)$ by the appropriate growth factor $GF_{kj}(t_p)$ to project future uncontrolled emissions
- Allocating the projected increase in activity to the portion governed by NSPS and the portion governed by existing standards, and adjusting the projected uncontrolled emissions to account for the effects of required emission control.

(4) Transportation Area Source Activity

Activity for the following five transportation source categories is projected by the REPS system:

- Highway vehicles
- Off-highway vehicles
- Rail locomotives
- Vessels
- Aircraft.

The following section contains a description of the projection methodology for highway vehicles. This is followed by a section describing the projection methodology for the four remaining transportation source categories.

1. Highway Vehicles

Base year activity for highway vehicles is defined in NEDS in terms of two types of related data: fuel use by vehicle type (light-duty gasoline, heavy-duty gasoline and heavy-duty diesel vehicles) and measured vehicle miles travelled (VMT) by average road speed class (limited access, rural, suburban and urban roads). Inclusion of fuel use data is mandatory for the NEDS area source inventory; VMT data are optional and are included when available. Consequently the projection data include either fuel use only, or fuel use and VMT, depending on the type of data included in the NEDS base year inventory. The approach used in REPS to project transportation activity depends in part on the method used in the NEDS summary reporting programs to compute emissions from transportation activity. The NE11 program computes emissions in one of two ways:

- If measured VMT are given, the VMT for each road speed class are allocated to the three vehicle categories based on fuel-use and nationwide estimates of average miles per gallon. Emissions are computed using emission factors which reflect the average vehicle speed for each road speed class.

- If measured VMT are not given, fuel use for each vehicle category is converted to VMT using nationwide average miles per gallon, and these data are then converted to emissions using emission factors which are based on nationwide average vehicle speeds.

Thus all growth information developed internally in REPS, or supplied by the user, must be translated to expected change in fuel-use or VMT.

While the general approach used in REPS to estimate future transportation activity involves using scalar growth factors to project base year activity to the future, the specific approach utilized in the program for a given area source record depends on both the type of override data, if any, supplied by the user, and whether VMT data are given in the base year NEDS inventory. There are five different calculation methods for projecting future activity; Table II-3 identifies the approach corresponding to all possible combinations of user supplied data, as a function of whether VMT data were given in the base year inventory.

Table II-3
Method of Projecting Highway Vehicle Activity As Determined By the Input Data

USER SUPPLIED DATA			VMT GIVEN IN NEDS		
GVMT	RFU	GFU	NO	YES	
			3	1	Projection Method (1 through 5)
●			3	1	
	●		5	2	
●	●		5	2	
		●	3	4	
●		●	3	1	
	●	●	3	4	
●	●	●	3	1	

For example, if both GVMT and RFT are supplied by the user, and VMT data are included in NEDS, Method 2 is used to project activity.

The five alternate projection methods are as follows:

- Method 1

  Projected VMT for highway class m is given by

$$VMT_m(t_p) = VMT_m(t_o) \cdot GV_m^*(t_p) \qquad (23)$$

If $GV^*_m(t_p)$ is not given by the user then

$$VMT_m(t_p) = VMT_m(t_o) \cdot GP^*(t_p) \qquad (24)$$

- Method 2

  Projected VMT for highway class m, obtained as in Method 1, is given by equations 23 and 24. Projected fuel use for vehicle type n is then computed from total projected VMT and user-supplied data defining the projected share of total VMT:

$$FU_n(t_p) = \left[\sum_m VMT_m(t_p)\right] \cdot RT^*_n(t_p)/MG_n \qquad (25)$$

- Method 3

  Projected fuel use for vehicle type n is computed based on growth factors for each vehicle type:

$$FU_n(t_p) = FU_n(t_o) \cdot GFU^*_n(t_p) \qquad (26)$$

- Method 4

  Projected fuel use for vehicle type n is computed as in Method 3, according to equation (26). If $GFU^*_n(t_p)$ is not given then

$$FU_n(t_p) = FU_n(t_o) \cdot GP^*(t_p) \qquad (27)$$

These fuel projections and the base year VMT are used to compute projected VMT for each highway class m:

$$VMT_m(t_p) = VMT_m(t_o) \cdot \sum_n (FU_n(t_p) \cdot MG_n)/\sum_m VMT_m(t_o) \qquad (28)$$

- Method 5

  Projected fuel use for vehicle type n is first computed as in Method 3, according to equation (26). These fuel projections are then adjusted to conform to the user-supplied data defining the projected share of total VMT for each vehicle type n:

$$FU_n(t_p) = \sum_n \left[FU_n(t_p) \cdot MG_n \right] \cdot RT_n^*(t_p)/MG_n \qquad (29)$$

The five preceding methods are used to project future activity (VMT and fuel use) for highway vehicles. These data are then entered in the projected area source inventory. In addition, REPS computes emissions from highway vehicles based on this projected activity and includes these emissions in the printed output of the system. Emissions are calculated according to the method specified in EPA document AP-42. This method involves computing weighted emission factors appropriate for projection years which include the effects of vehicle age and model year distribution. The data used to compute these weighted emission factors, also taken from document AP-42 and Attachment No. 1 and Supplement No. 2 to AP-42, included low altitude, non-California test emission factors and national model year distributions. For more information on the method or data, consult document AP-42.

2. Off-Highway Vehicles, Rail, Vessels, and Aircraft

Base year activity is given in terms of landing-takeoff cycles (LTO) for aircraft, and in terms of fuel-use for all other sources. In general, activity is projected by multiplying base year activity for each source category by a scalar growth factor reflecting the expected change in activity for that category. The general equation for projecting fuel-use for off-highway vehicles, rail locomotives and vessels for source category q is:

$$FV_q(t_p) = FV_q(t_o) \cdot G(t_p) \quad , \qquad (30)$$

where $G(t_p)$ is the appropriate growth factor (see below). The general equation for projecting LTO cycles for aircraft type r is

$$LT_r(t_p) = LT_r(t_o) \cdot G(t_p) \quad , \qquad (51)$$

where again $G(t_p)$ is the appropriate growth factor.

The growth factors for non-highway source categories are as follows:

- Off-highway vehicles:
  - Diesel: $G(t_p) = GFV_q^*(t_p)$, otherwise $GI^*(t_p)$
  - Gasoline: $G(t_p) = GFV_q^*(t_p)$, otherwise $GP^*(t_p)$
- Rail Locomotives: $G(t_p) = GFV_q^*(t_p)$, other- $GP^*(t_p)$
- Vessels
  - Diesel: $G(t_p) = GFV_q^*(t_p)$, otherwise $GI^*(t_p)$
  - Residual Oil: $G(t_p) = GFV_q^*(t_p)$, otherwise $GI^*(t_p)$
  - Bituminous coal: $G(t_p) = GFV_q^*(t_p)$, otherwise $GI^*(t_p)$
  - Gasoline: $G(t_p) = GFV_q^*(t_p)$, otherwise $GP^*(t_p)$
- Aircraft
  - Commercial: $G(t_p) = GFA_r^*(t_p)$, otherwise $GP^*(t_p)$
  - Civil: $G(t_p) = GFA_r^*(t_p)$, otherwise $GP^*(t_p)$

- Military: $G(t_p) = GFA_r^*(t_p)$, otherwise $GM^*(t_p)$.

The option in each case is used when the user does not provide input data.

(5) <u>Area Source Fuel Combustion and Solid Waste Disposal Activity</u>

In general, future area source fuel combustion is estimated by projecting the Btu demand for each customer category and allocating that demand to the fuel mix for the projection year. Future levels of area source solid waste disposal are estimated by projecting the future level of solid waste disposal for each customer category, and distributing that amount among the various methods of disposal. The specific approaches for projecting these area source activities are given below. Activity for each area source reporting region (usually a county) is projected independently in REPS. However, user supplied data for area source projections are applied to all regions. The equations presented refer to data for a given reporting region.

The methodology for projecting emissions from area source fuel combustion is as follows. Base year Btu demand for fuel j and customer category k within the AQCR is given by

$$BA_{kj}(t_o) = FA_{kj}(t_o) \cdot BTU_j \tag{32}$$

where $FA_{kj}(t_o)$ is the consumption of fuel j within the customer category k and BTU_j is the Btu equivalent for fuel j. Total base year Btu demand for customer category k is given by

$$BD_k(t_o) = \sum_j BA_{jk}(t_o) \tag{33}$$

Base year fuel use ratios are given by

$$RA_{kj}(t_o) = BA_{kj}(t_o)/BD_k(t_o) \tag{34}$$

and future Btu demand for each customer category is

$$BD_k(t_p) = BD_k(t_o) \cdot G(t_p) \quad , \tag{35}$$

where:

- $G(t_p) = GP^*(t_p) \cdot RE^*(t_p)$ for the residential customer category. $RE^*(t_p)$ is the user-supplied factor reflecting the change in the projected fossil fuel Btu demand due to substitution of electricity. If $PE^*(t)$ is the percent of total residential space heating and cooling Btu demand satisfied by electricity in year t, then the change in the projected residential Btu demand for space conditioning is

  $$RE^*(t_p) = \left[1 - PE^*(t_p)\right] / \left[1 - PE^*(t_o)\right] \tag{36}$$

  If $RE^*(t_p)$ is not supplied by the user, it is assumed to be 1.0, indicating that electricity in the projection year will account for the same share of the residential Btu space conditioning demand as it did in the base year.

- $G(t_p) = GE^*(t_p)$ for the commercial/institutional customer category

- $G(t_p) = GI^*(t_p)$ for the industrial customers category.

The projected fuel use for fuel j in customer category k is

$$FA_{kj}(t_p) = BD_k(t_p) \cdot RA^*_{kj}(t_p)/BTU_j \tag{37}$$

Where $RA^*_{kj}(t_p)$ is the user-supplied fuel mix for the projection year. If the user does not supply $RA^*_{kj}(t_p)$, then the base year fuel mixes are used.

$$RA_{kj}(t_p) = RA_{kj}(t_o) \tag{38}$$

The projection methodology for area source emissions from solid waste disposal is as follows. The base year solid waste level for customer category k is given by

$$SD_k(t_o) = \sum_p SA_{kp}(t_o) \tag{39}$$

where $SA_{kp}(t_o)$ is the solid waste for customer category k disposed of by method p. The base year disposal method ratios are given.

$$RS_{kp}(t_o) = SA_{kp}(t_o)/SD_k(t_o) \tag{40}$$

Future solid waste levels are given by

$$SD_k(t_p) = SD_k(t_o) \cdot G(t_p) \tag{41}$$

Where

- $G(t_p) = GP^*(t_p)$, for the residential customer category
- $G(t_p) = GE^*(t_p)$, for the commercial/institutional customer category
- $G(t_p) = GI^*(t_p)$, for the industrial customer category.

The projected levels of solid waste for disposal method p within customer category k is

$$SA_{kp}(t_p) = SD_k(t_p) \cdot RS^*_{kp}(t_p) \tag{42}$$

where $RS^*_{kp}(t_p)$ is the user-supplied disposal method ratio for the projection year. If the user does not supply $RS^*_{kp}(t_p)$ then the base year ratios are used,

$$RS_{kp}(t_p) = RS_{kp}(t_o). \tag{43}$$

* * * * *

This Section has presented the analytical methods and procedures used in the REPS projection system. There are implicit in the methods used a number of important assumptions which have been identified in the text. It is emphasized that, although the equations which have been used in REPS are considered to be reasonable, they could certainly be refined substantially to achieve greater projection accuracy in many cases, and it is expected that the REPS methodology will be almost continually improved.

Chapter III of this documentation provides a detailed description of the computational procedures used to translate the methodology defined and described here into a working model. The following, and final, section of this chapter presents a brief overview of the techniques used to implement the model.

6. ADP IMPLEMENTATION OF THE REPS SYSTEM

The preceding sections of this chapter contain a presentation of the functional and mathematical procedures used in the REPS system to forecast future activity and emissions. The mathematical model described by the equations given above has been implemented on the EPA's UNIVAC 1110 computer system and is fully operational at the present time. In this section an overview of the present computer program configuration of the REPS system is given. This overview focuses on identifying the correspondence between elements of the projection methodology discussed previously and program elements of the computerized projection system. In addition, a brief functional description of the various computer programs which form the REPS system is also given.

A functional system flow diagram is given in Figure II-4. The figure identifies the various modules of the REPS system, illustrates the flow of information within the system, and identifies the correspondence between program modules and the four primary sources of input data discussed earlier in this chapter.

Referring to Figure II-4, it can be seen that the REPS system is modular in structure, consisting of a number of independent programs. Additional segmentation within the complex REPS module is achieved by distributing the program's operations to various subroutines. All the modules are grouped into two distinct subsystems, the static system and the dynamic system.

The purpose of the static system is to process all the exogenous input data which are static in nature and to organize these data for access by the dynamic system. These exogenous data include the SEAS and OBERS projections containing economic and demographic forecast information, and the file of emission factors incorporated in NEDS. Modules of the static system need be executed only if any of the exogenous input data are modified or updated. The dynamic system reads all input data, both econometric and emission-related, which are necessary to develop emission projections for the AQCR and for the year of interest. The emission projections are developed by modifying the data in the base year emission inventory to reflect changes in activity levels and emission control, while preserving the format and structure of the inventory records. Projections for other years or geographic regions require additional executions of the dynamic system.

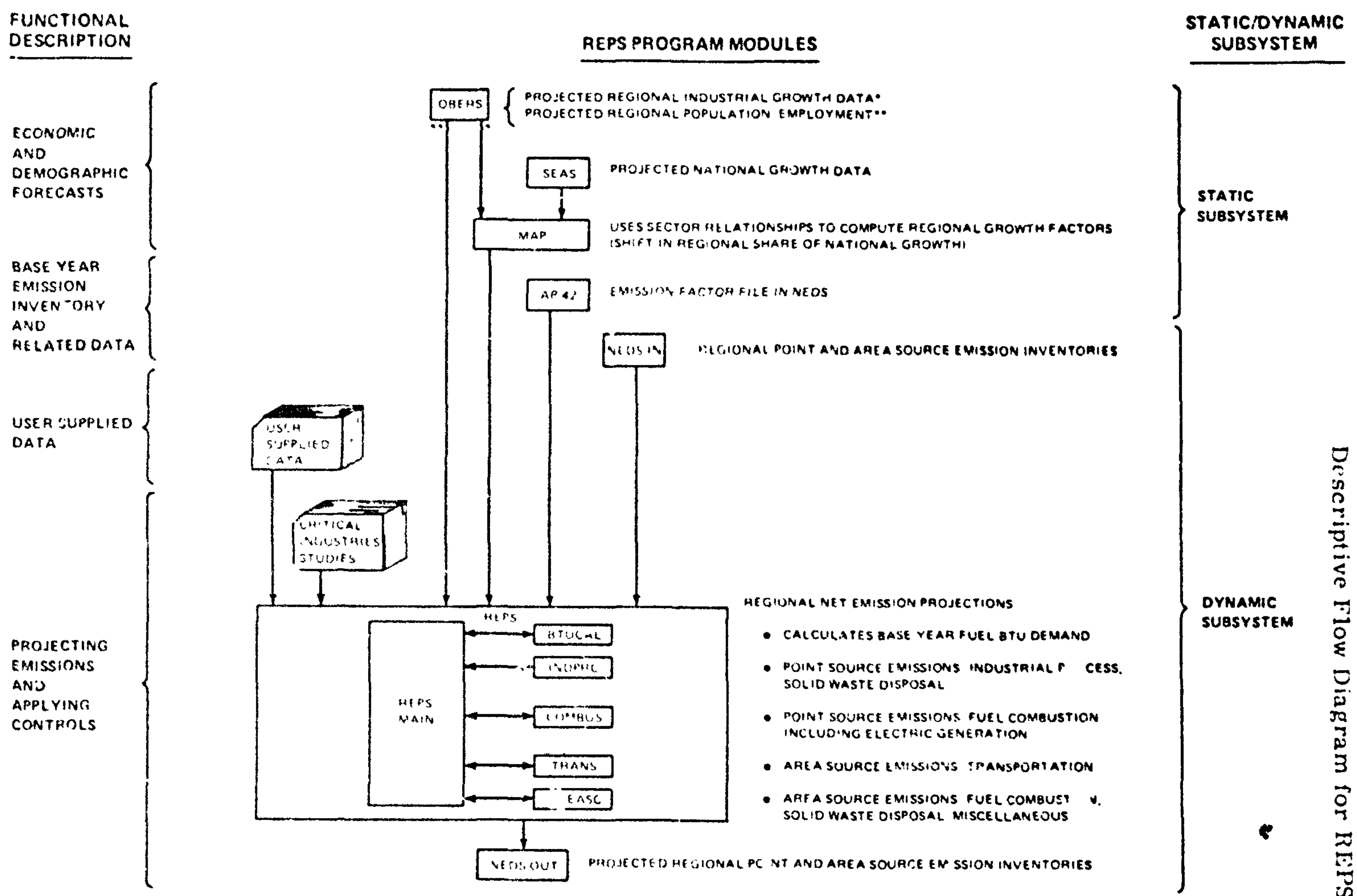


FIGURE II-4
Descriptive Flow Diagram for REPS

The modular approach was used in designing the REPS computer system in order to maximize the efficiency of projecting emission for a large number of geographic regions. Only the dynamic system must be executed to produce emission projections. Furthermore, when running certain projection scenarios, only a limited number of the modules of the dynamic system may need to be executed. The modularity of the system eliminates redundant or unnecessary operations, resulting in the REPS system being a valuable tool for scenario projections because the required CPU time and operator assistance are minimized.

In order to produce emission projections using the REPS system, the user must specify only the AQCR and the projection year. When he inputs that information via punched cards he may at his option also input the card deck containing growth data for the five critical industries. While this is the minimum input required of the user, he may of course override virtually all the data used by the system to predict growth for every emission source, and he may supplement the data concerning future allowable emissions with state or local emission control regulations. Identification of all available user-supplied input data is given in Chapter III, which contains complete program documentation of all REPS modules in standard AEROS format.

The output of the REPS system is in two forms. One is the projected point and area source emission inventory given in the standard format of the NEDS system. All of the NEDS summary reporting programs may, therefore, be executed against the projected inventory. One of these reporting programs is the NE11 program, which aggregates all emissions into the National Emission Report (NER) format. Also, air quality models which convert annual emission levels, as given in the emission inventory, directly to ambient air quality, may be used.

The other principal output of the REPS system is a printed summary of projection statistics and error messages which occurred during execution of the program. This printout is valuable both for interpreting the projection results, and interpreting any computer problems which may have occurred. This summary contains:

- Listing of user-supplied override data
- Assumptions and defaults exercised

- Base year and projected fuel mix
- Automobile emission factors for the projection year
- Other related projection data developed by the program.

Any errors encountered during program execution are also included in the output.

The format of the projected point and area source emission inventory, as well as identification and interpretation of all possible diagnostic and error messages is given in Chapter III. A summary printout of the REPS system for a typical projection scenario is given on the following pages.

PROJECTION DATA OF AREA 1 FOR 1975

MISCELLANEOUS O•B•E•R•S GROWTH DATA

YEAR	POPULATION (POP)	CIV-EMPLOYMENT (CEMPL)	MIL-EMPLOYMENT (CEMPM)	GROSS-PRODUCT-ORIG (CGPO)	
1	[illegible]	.1132+07	.3470+02	.2219+07	BASE YEAR VALUE
2	1.007	[illegible]	1.013	1.043	PROJECTED GROWTH MULTIPLIER
3	[illegible]	[illegible]	1.047	1.097	PROJECTED GROWTH MULTIPLIER
4	1.022	1.086	1.072	1.151	PROJECTED GROWTH MULTIPLIER
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	PROJECTED GROWTH MULTIPLIER
6	[illegible]	[illegible]	1.116	1.259	PROJECTED GROWTH MULTIPLIER
7	[illegible]	[illegible]	[illegible]	1.313	PROJECTED GROWTH MULTIPLIER
[illegible]	1.054	[illegible]	[illegible]	1.369	PROJECTED GROWTH MULTIPLIER
[illegible]	1.064	[illegible]	1.142	[illegible]	PROJECTED GROWTH MULTIPLIER
10	[illegible]	1.231	1.143	1.480	PROJECTED GROWTH MULTIPLIER
11	1.082	1.249	[illegible]	1.536	PROJECTED GROWTH MULTIPLIER
12	[illegible]	1.264	1.141	1.592	PROJECTED GROWTH MULTIPLIER
13	[illegible]	1.287	1.142	1.660	PROJECTED GROWTH MULTIPLIER
14	[illegible]	[illegible]	1.141	1.727	PROJECTED GROWTH MULTIPLIER
15	[illegible]	[illegible]	[illegible]	1.795	PROJECTED GROWTH MULTIPLIER
16	[illegible]	[illegible]	[illegible]	1.862	PROJECTED GROWTH MULTIPLIER
17	[illegible]	1.350	1.129	1.930	PROJECTED GROWTH MULTIPLIER
18	[illegible]	1.372	[illegible]	2.017	PROJECTED GROWTH MULTIPLIER
19	1.160	1.390	1.135	2.103	PROJECTED GROWTH MULTIPLIER
20	1.170	1.401	1.135	2.189	PROJECTED GROWTH MULTIPLIER
21	1.180	1.413	[illegible]	2.276	PROJECTED GROWTH MULTIPLIER
22	[illegible]	1.419	[illegible]	2.362	PROJECTED GROWTH MULTIPLIER
23	[illegible]	1.424	[illegible]	2.467	PROJECTED GROWTH MULTIPLIER
24	1.210	1.444	[illegible]	2.573	PROJECTED GROWTH MULTIPLIER
25	[illegible]	1.449	1.126	2.679	PROJECTED GROWTH MULTIPLIER
26	1.232	1.449	1.121	2.784	PROJECTED GROWTH MULTIPLIER
27	[illegible]	1.444	1.115	2.890	PROJECTED GROWTH MULTIPLIER

```
                    ** USER OVERRIDE OPTIONS EXERCISED **

                        (IF *******, DEFAULT VALUE USED)

                              VARIABLES REFERENCE

CPOP   - OBERS GROWTH IN POPULATION                    GEMPL  - OBERS GROWTH IN CIVILIAN EMPLOYMENT
GEMIL  - OBERS GROWTH IN MILITARY EMPLOYMENT           CGPO   - OBERS GROWTH IN GROSS PRODUCT ORIGINATING
RFFT   - RESIDENTIAL AREA FUELS ARRAY                  RFFC   - COMM-INSTITUTIONAL AREA FUELS ARRAY
FFPI   - INDUSTRIAL AREA FUELS ARRAY                   CR     - SOLID WASTE (RESIDENTIAL) ARRAY
CC     - SOLID WASTE (COMM-INSTIT) ARRAY               CI     - SOLID WASTE (INDUSTRIAL) ARRAY
GBTU   - GROWTH IN BTU DEMAND                          ERATIO - ELECTRICAL ENERGY RATIO (BTU)
PAI    - PORT AUTHORITY INDEX (GROWTH)                 URF    - POINT SOURCES FUEL RATIOS ARRAY
GVMT   - GROWTH IN VEHICULAR MILES TRAVELED ARRAY      GFU    - GROWTH IN VEHICULE FUEL USAGE ARRAY
RFU    - VEHICULAR FUEL RATIOS ARRAY

  PRINT OPTION FOR DETAIL LISTING IS ON

                         ** END OF USER OPTIONS **

                  FUEL MIX CALCULATION - OUTPUT SECTION

                         END OF NEDS FILE REACHED
```

FUEL MIX RATIOS FOR NEDS COMBUSTION CATEGORIES

	EXT-EL	EXT-IN	EXT-C/	INT-EL	INT-IN	INT-C/	INT-EN
ANTHRA/TOTAL	.000	.000	.000	.000	.000	.000	.000
BITUMI/TOTAL	.000	.000	.000	.000	.000	.000	.000
LIGNIT/TOTAL	.000	.000	.000	.000	.000	.000	.000
DISTIL/TOTAL	.000	.000	.000	.000	.000	.000	.000
RESIDU/TOTAL	.000	.000	.000	.000	.000	.000	.000
NAT GA/TOTAL	.000	.17[illegible]	.000	.000	.000	.000	.000
PROC G/TOTAL	.000	.000	.000	.000	.000	.000	.000
COKE /TOTAL	.000	.000	.000	.000	.000	.000	.000
WOOD /TOTAL	.000	.73[illegible]	.000	.000	.000	.000	.000
L-P GA/TOTAL	.000	.000	.000	.000	.000	.000	.000
BAGASS/TOTAL	.000	.000	.000	.000	.000	.000	.000
[illegible]/TOTAL	.000	.000	.000	.000	.000	.000	.000
[illegible]/TOTAL	.000	.000	.000	.000	.000	.000	.000
[illegible]/TOTAL	.000	.000	.000	.000	.000	.000	.000
[illegible]/TOTAL	.000	.000	.000	.000	.000	.000	.000
TOTALBTU	.000	.223+08	.000	.000	.000	.000	.000

GROWTH MULTIPLIERS FOR COMBUSTION CATEGORIES

YEAR	EXT-EL	EXT-IN	EXT-C/	INT-EL	INT-IN	INT-C/	INT-EN
1	.000	1.000	.000	.000	.000	.000	.000
2	.000	1.003	.000	.000	.000	.000	.000
3	.000	.997	.000	.000	.000	.000	.000
4	.000	.992	.000	.000	.000	.000	.000
5	.000	.997	.000	.000	.000	.000	.000
6	.000	.993	.000	.000	.000	.000	.000
7	.000	.979	.000	.000	.000	.000	.000
8	.000	.987	.000	.000	.000	.000	.000
9	.000	.994	.000	.000	.000	.000	.000
10	.000	1.001	.000	.000	.000	.000	.000
11	.000	1.007	.000	.000	.000	.000	.000
12	.000	1.013	.000	.000	.000	.000	.000
13	.000	1.021	.000	.000	.000	.000	.000
14	.000	1.026	.000	.000	.000	.000	.000
15	.000	1.035	.000	.000	.000	.000	.000
16	.000	1.041	.000	.000	.000	.000	.000
17	.000	1.047	.000	.000	.000	.000	.000
18	.000	1.054	.000	.000	.000	.000	.000
19	.000	1.060	.000	.000	.000	.000	.000
20	.000	1.065	.000	.000	.000	.000	.000
21	.000	1.071	.000	.000	.000	.000	.000
22	.000	1.075	.000	.000	.000	.000	.000
23	.000	1.082	.000	.000	.000	.000	.000
24	.000	1.098	.000	.000	.000	.000	.000
25	.000	1.094	.000	.000	.000	.000	.000
26	.000	1.099	.000	.000	.000	.000	.000
27	.000	1.104	.000	.000	.000	.000	.000

3

FUEL MIX RATIOS FOR NECC SOLID WASTE CATEGORIES

	SW-COV	SW-O/I	SW-IND
MUNC I/TOTAL	.000	.000	.000
OPEN D/TOTAL	.000	.000	.000
AFT IN/TOTAL	.000	.000	.000
RP BUR/TOTAL	.000	.000	.000
INCINE/TOTAL	.000	.000	.000
AUTO B/TOTAL	.000	.000	.000
TOTALSTU	.000	.000	.000

GROWTH MULTIPLIERS FOR SOLID WASTE CATEGORIES

YEAR	SW-COV	SW-O/I	SW-IND
1	.000	.000	.000
2	.000	.000	.000
3	.000	.000	.000
4	.000	.000	.000
5	.000	.000	.000
6	.000	.000	.000
7	.000	.000	.000
8	.000	.000	.000
9	.000	.000	.000
10	.000	.000	.000
11	.000	.000	.000
12	.000	.000	.000
13	.000	.000	.000
14	.000	.000	.000
15	.000	.000	.000
16	.000	.000	.000
17	.000	.000	.000
18	.000	.000	.000
19	.000	.000	.000
20	.000	.000	.000
21	.000	.000	.000
22	.000	.000	.000
23	.000	.000	.000
24	.000	.000	.000
25	.000	.000	.000
26	.000	.000	.000
27	.000	.000	.000

UNABLE TO LOCATE / E-O-F FOR COMP-STATUS ABCR= 2

DETAIL LISTING OF [illegible] POINT RECORDS

[illegible]	PART	[illegible]	NOX	HC	CO	GROWTH	PROCESSING MESSAGES (PRIOR TO DISPLAY)
10[illegible]0401	23[illegible]	44767	7372	368	491	1.0030	
10[illegible]0402	13[illegible]	21[illegible]42	3420	172	229	1.0030	
[illegible]0403	1[illegible]4	[illegible]	[illegible]175	259	345	1.0030	
[illegible]	[illegible]	[illegible]	12590	[illegible]	[illegible]	1.0030	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	877	1.0030	
[illegible]0501	23[illegible]	33	3794[illegible]	499	2224	1.0030	
[illegible]	[illegible]	71	14[illegible]	[illegible]	[illegible]	1.0030	
10200503	14[illegible]	47	[illegible]	233	1247	1.0030	
10[illegible]0902	87[illegible]	39[illegible]7	25[illegible]7.4	[illegible]2743	[illegible]2743	1.0030	
							ALLOWABLE EMISSIONS SUBSTITUTED
[illegible]	[illegible]	52[illegible]	[illegible]	[illegible]9135	[illegible]175	1.0030	
[illegible]	87[illegible]24	[illegible]	[illegible]	[illegible]2742	52742	1.0030	
							ALLOWABLE EMISSIONS SUBSTITUTED
[illegible]	11	[illegible]	[illegible]	[illegible]	2006	1.0030	
							ALLOWABLE EMISSIONS SUBSTITUTED
10200902	11	1505	10030	2006	2006	1.0030	
							ALLOWABLE EMISSIONS SUBSTITUTED
10200902	11	1505	10030	2006	2006	1.0030	

DETAIL LISTING OF PROJECTED POINT RECORDS

SCC	PART	SOX	NOX	HC	CO	GROWTH	PROCESSING MESSAGES (PRIOR TO DISPLAY)
30100505	1792	35640	0	1705770	17833200	.9300	
30 1 05 99	9.0	0	0	0	0	.9300	ALLOWABLE EMISSIONS SUBSTITUTED
[illegible]	77	0	0	0	0	.9300	ALLOWABLE EMISSIONS SUBSTITUTED
30 10 30 99	75	0	0	0	0	.3900	ALLOWABLE EMISSIONS SUBSTITUTED
30 20 04 01	4	0	0	0	0	.3950	ALLOWABLE EMISSIONS SUBSTITUTED
30 20 04 01	7	0	0	0	0	.3950	ALLOWABLE EMISSIONS SUBSTITUTED
30 20 04 01	2	0	0	0	0	.3950	ALLOWABLE EMISSIONS SUBSTITUTED
30 20 04 01	4	0	0	0	0	.3950	ALLOWABLE EMISSIONS SUBSTITUTED
30 20 04 01	6	0	0	0	0	.9950	ALLOWABLE EMISSIONS SUBSTITUTED
30 20 04 01	1	0	0	0	0	.3950	ALLOWABLE EMISSIONS SUBSTITUTED
30 20 04 01	4	0	0	0	0	.9950	ALLOWABLE EMISSIONS SUBSTITUTED
30 20 04 01	7	0	0	0	0	.3950	ALLOWABLE EMISSIONS SUBSTITUTED
30 20 04 01	2	0	0	0	0	.9950	ALLOWABLE EMISSIONS SUBSTITUTED
30 20 04 01	5	0	0	0	0	.9350	ALLOWABLE EMISSIONS SUBSTITUTED
30 20 04 01	4	0	0	0	0	.9950	ALLOWABLE EMISSIONS SUBSTITUTED
30 20 04 01	4	0	0	0	0	.9950	ALLOWABLE EMISSIONS SUBSTITUTED
30 20 04 01	3	0	0	0	0	.9350	ALLOWABLE EMISSIONS SUBSTITUTED
30 20 04 01	6	0	0	0	3	.9950	ALLOWABLE EMISSIONS SUBSTITUTED
30 20 04 01	4	0	0	0	0	.3950	ALLOWABLE EMISSIONS SUBSTITUTED
30 20 04 01	2	0	0	0	0	.9950	ALLOWABLE EMISSIONS SUBSTITUTED
30 20 04 02	4	0	0	0	0	.9950	ALLOWABLE EMISSIONS SUBSTITUTED
30 20 04 02	6	0	0	0	0	.9950	ALLOWABLE EMISSIONS SUBSTITUTED
30 20 04 02	2	0	0	0	0	.9950	ALLOWABLE EMISSIONS SUBSTITUTED
30 20 04 02	3	0	0	0	0	.9950	ALLOWABLE EMISSIONS SUBSTITUTED
30 20 04 02	6	0	0	0	0	.9950	ALLOWABLE EMISSIONS SUBSTITUTED
30 20 04 02	4	0	0	0	0	.9950	ALLOWABLE EMISSIONS SUBSTITUTED
30 20 04 02	5	0	0	0	0	.3950	

30200402	[illegible]		0	0	0	.9950 ALLOWABLE EMISSIONS SUBSTITUTED
30200402	3		0	0	0	.9950 ALLOWABLE EMISSIONS SUBSTITUTED
30200402	4	0	0	0	0	.9950 ALLOWABLE EMISSIONS SUBSTITUTED
30200402	1	0	0	0	0	.9950 ALLOWABLE EMISSIONS SUBSTITUTED
30200402	4	0	0	0	0	.9950 ALLOWABLE EMISSIONS SUBSTITUTED
30200402	4	0		0	0	.9950 ALLOWABLE EMISSIONS SUBSTITUTED
30200402	2	0	0	0	0	.9950 ALLOWABLE EMISSIONS SUBSTITUTED
30200402	2	0	0	0	0	.9950 ALLOWABLE EMISSIONS SUBSTITUTED
30200402	4	0	0	0	0	.9950 ALLOWABLE EMISSIONS SUBSTITUTED
30200403	3	0	0	0	0	.9950 ALLOWABLE EMISSIONS SUBSTITUTED
30200403	2	0	0	0	0	.9950 ALLOWABLE EMISSIONS SUBSTITUTED
30200403	[illegible]	0	0	0	0	.9950 ALLOWABLE EMISSIONS SUBSTITUTED
30200403	4	0	0	0	0	.9950 ALLOWABLE EMISSIONS SUBSTITUTED
30200403	1	0	0	0	0	.9950 ALLOWABLE EMISSIONS SUBSTITUTED
30200403	4	0	0	0	0	.9950 ALLOWABLE EMISSIONS SUBSTITUTED
30200403	4	0	0	0	0	.9950 ALLOWABLE EMISSIONS SUBSTITUTED
30200403	3	0	0	0	0	.9950 ALLOWABLE EMISSIONS SUBSTITUTED
30200403	5	0	0	0	0	.9950 ALLOWABLE EMISSIONS SUBSTITUTED
30200403	2	0	0	0	0	.9950 ALLOWABLE EMISSIONS SUBSTITUTED
30200403	4	0	0	0	0	.9950 ALLOWABLE EMISSIONS SUBSTITUTED
30200403	6	0	0	0	0	.9950 ALLOWABLE EMISSIONS SUBSTITUTED
30200403	2	0	0	0	0	.9950 ALLOWABLE EMISSIONS SUBSTITUTED
30200403	6	0	0	0	0	.9950 ALLOWABLE EMISSIONS SUBSTITUTED
30200403	7	0	0	0	0	.9950 ALLOWABLE EMISSIONS SUBSTITUTED
30200403	4	1	0	0	0	.9950 ALLOWABLE EMISSIONS SUBSTITUTED
30200493	0	0	0	0	0	.9950
30200493	0	0	0	0	0	.9950
30200493	0	0	0	0	0	.9950
30200493	0	0	0	0	0	.9950
30200493	2	0	0	0	0	.9950 ALLOWABLE EMISSIONS SUBSTITUTED
30200493	0	0	0	0	0	.9950

[illegible]	[illegible]		[illegible]	0	0	.3350	
[illegible]	[illegible]				[illegible]	.3350	
[illegible]	[illegible]				0	.9950	
[illegible]	[illegible]			0	0	.9950	
[illegible]	[illegible]			0	0	.9950	
[illegible]	0		0	0	0	.9950	
[illegible]	0		0	0	0	.9950	
[illegible]	[illegible]		0	0	0	.9950	
[illegible]	[illegible]		0	0	0	.9950	
[illegible]	[illegible]		0	0	0	.9950	
[illegible]	30		0	0	0	1.0010	ALLOWABLE EMISSIONS SUBSTITUTED
[illegible]	[illegible]	0	0	0	0	1.0010	ALLOWABLE EMISSIONS SUBSTITUTED
[illegible]	0	0	0	0	0	1.0010	
[illegible]	0		0	0	0	1.0010	
[illegible]	21			0	0	.9650	ALLOWABLE EMISSIONS SUBSTITUTED
[illegible]	1357	0		0	0	.9650	
30400301	13	0	0	0	249813	.9650	ALLOWABLE EMISSIONS SUBSTITUTED
30400302	7	0	0	0	230346	.9650	ALLOWABLE EMISSIONS SUBSTITUTED
[illegible]	20	261	0	0	231372	.9650	ALLOWABLE EMISSIONS SUBSTITUTED
[illegible]	1	0	0	0	24981	.9650	ALLOWABLE EMISSIONS SUBSTITUTED
[illegible]	1446		0	0	0	.9650	
30400393	0	0	0	0	0	.9650	
30400399	0	0	0	0	0	.9650	
[illegible]	31	227961	0	0	0	.9650	ALLOWABLE EMISSIONS SUBSTITUTED
[illegible]	2447	[illegible]	0	0	0	.9650	
[illegible]	13751	0	0	0	0	.9650	
[illegible]	12650	0	0	0	0	.9650	
30500201	13	1055	0	0	0	1.0550	ALLOWABLE EMISSIONS SUBSTITUTED
30500201	7	0	0	0	0	1.0550	ALLOWABLE EMISSIONS SUBSTITUTED
[illegible]	15	0	0	0	0	1.0550	ALLOWABLE EMISSIONS SUBSTITUTED
[illegible]	17	0	0	0	0	1.0550	ALLOWABLE EMISSIONS SUBSTITUTED
[illegible]	9	0	0	0	0	1.0550	ALLOWABLE EMISSIONS SUBSTITUTED
[illegible]	3977	0	0	0	0	1.0550	
[illegible]	[illegible]	0	0	0	0	1.0550	ALLOWABLE EMISSIONS SUBSTITUTED
[illegible]	22155	0	0	0	0	1.0550	
[illegible]	1	0	0	0	0	1.0550	ALLOWABLE EMISSIONS SUBSTITUTED
[illegible]	23	724	0	0	0	1.0550	ALLOWABLE EMISSIONS SUBSTITUTED
[illegible]	29	[illegible]	0	0	0	1.0550	ALLOWABLE EMISSIONS SUBSTITUTED
[illegible]	29	[illegible]	0	0	0	1.0550	ALLOWABLE EMISSIONS SUBSTITUTED

							ALLOWABLE EMISSIONS SUBSTITUTED
						1.0000	ALLOWABLE EMISSIONS SUBSTITUTED
[illegible]	[illegible]	[illegible]				1.0000	
[illegible]	[illegible]	0	0	0	0	1.0000	
[illegible]	[illegible]	[illegible]	0	0	0	1.0000	
[illegible]	[illegible]	[illegible]	[illegible]	0	0	1.0000	
[illegible]	[illegible]	[illegible]	[illegible]	0	0	1.0000	ALLOWABLE EMISSIONS SUBSTITUTED
[illegible]	[illegible]	0	0	0	0	1.0000	ALLOWABLE EMISSIONS SUBSTITUTED
[illegible]	[illegible]	0	0	0	0	1.0000	
[illegible]	[illegible]	0	0	0	0	1.0000	
[illegible]	[illegible]	0	0	0	0	1.0000	
[illegible]	[illegible]	0	0	0	0	1.0000	
[illegible]	[illegible]	0	0	0	0	1.0000	
[illegible]	[illegible]	0	0	0	0	1.0000	
[illegible]	[illegible]	0	0	0	0	1.0000	
[illegible]	[illegible]	0	0	0	0	1.0000	
[illegible]	[illegible]	0	0	0	0	1.0000	
[illegible]	0	0	0	0	0	1.0000	
[illegible]	0	0	0	0	0	1.0000	
[illegible]	0	0	0	0	0	1.0000	
[illegible]	0	0	0	0	0	1.0000	
[illegible]	0	0	0	0	0	1.0000	
[illegible]	0	0	0	0	0	1.0000	
[illegible]	0	0	0	0	0	1.0000	
[illegible]	0	0	0	0	0	1.0000	
[illegible]	0	0	0	0	0	1.0000	
30700199	268270	0	0	0	0	.9950	
[illegible]	0	0	0	0	0	1.0000	
[illegible]	0	0	0	0	0	1.0000	
[illegible]	0	0	0	0	0	1.0000	
[illegible]	0	0	0	0	0	1.0000	
[illegible]	0	0	0	0	0	1.0000	ALLOWABLE EMISSIONS SUBSTITUTED
[illegible]	0	8	0	0	0	1.0000	
[illegible]	0	0	0	0	0	1.0000	
[illegible]	0	0	0	0	0	1.0000	ALLOWABLE EMISSIONS SUBSTITUTED
[illegible]		7	0	0	0	1.0000	ALLOWABLE EMISSIONS SUBSTITUTED
[illegible]	0	8	0	0	0	1.0000	ALLOWABLE EMISSIONS SUBSTITUTED
[illegible]	75	0	0	0	0	1.0000	
[illegible]	0	0	0	0	0	1.0000	
[illegible]	0	0	0	0	0	1.0000	
[illegible]	0	0	0	0	0	1.0000	
[illegible]	1540	0	0	0	0	1.0000	
[illegible]	0	0	0	0	0	1.0000	ALLOWABLE EMISSIONS SUBSTITUTED
[illegible]	75	0	0	0	0	1.0000	

END OF POINT RECORDS - NEDS

PRELIMINARY TRANSPORTATION DATA

C.M. [illegible] EMISSION FACTORS

[illegible]	[illegible]	[illegible]	.590+00	.130+00
[illegible]	.479+0[illegible]	.219+0[illegible]	.350+00	.200+00
[illegible]	[illegible]	[illegible]	.7[illegible]+00	[illegible]
[illegible]	[illegible]	[illegible]	.1[illegible]+01	[illegible]
[illegible]	.9[illegible]+02	[illegible]	.113+02	[illegible]+02

[illegible] TRANSPORTATION (ITRGNE 1)

GROWTH IN VMT -	1.007	1.007	1.007	1.007		
GROWTH IN FUEL [illegible]	1.007	1.007	1.007	1.007	1.007	1.007
CHANGE IN [illegible] RATIO. =	.000	.000	.000			

PROJECTED AREA DATA FOR STATE 1. COUNTY 240

RESDEN	0	[illegible]	18	0	61	35		
COM/IN	1	0	21	4	18	0		
INDUST	[illegible]	1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
INC-RE	0	[illegible]						
INC-I[illegible]	0	[illegible]						
INC-[illegible]	[illegible]	1[illegible]						
EVAP-[illegible]	24							
EVAP-G	115							
FUEL-V	10221	1593	161	1092	50	62		
AIRCRA	0	0	0					
VESSEL	0	0	0	46				
VEH-MI	0	0	0	0				

PROJECTED AREA DATA FOR STATE 1. COUNTY 520

RESDEN	0	21	3	0	20	56		
COM/IN	0	0	13	2	11	0		
INDUST	0	73	0	0	0	0	0	0
INC-RE	0	111						
INC-IN	0	1						
INC-C/	0	13						
EVAP-S	12							
EVAP-G	64							
FUEL-V	3789	527	135	528	25	30		
AIRCRA	0	0	0					
VESSEL	0	0	0	0				
VEH-MI	0	0	0	0				

PROJECTED AREA DATA FOR STATE 1. COUNTY 540

RESDEN	0	4	3	0	58	75		
COM/IN	1	0	27	4	133	0		
INDUST	0	290	0	0	0	0	0	0
INC-RE	0	201						

[illegible]	[illegible]	[illegible]						
[illegible]	[illegible]	[illegible]						
[illegible]	[illegible]							
[illegible]	14[illegible]							
FUEL-V	[illegible]	[illegible]	171	[illegible]	47	56		
AIRCRA	[illegible]	0	[illegible]					
VESSEL	0	[illegible]	0	0				
VEH-MI	[illegible]	[illegible]	[illegible]	[illegible]				

PROJECTED AREA DATA FOR STATE 1, COUNTY 900

REGION	[illegible]	[illegible]	5	[illegible]	13	49		
COM/IN	0	[illegible]	14	[illegible]	1	0		
INDUST	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0
IND-RE	[illegible]	[illegible]						
IND-IN	[illegible]	[illegible]						
IND-C/	[illegible]	17						
EVAP-S	[illegible]							
EVAP-G	[illegible]							
FUEL-V	[illegible]	[illegible]	171	[illegible]	28	33		
AIRCRA	[illegible]	[illegible]	[illegible]					
VESSEL	[illegible]	[illegible]	[illegible]	[illegible]				
VEH-MI	0	[illegible]	[illegible]	[illegible]				

PROJECTED AREA DATA FOR STATE 1, COUNTY 1190

REGION	[illegible]	[illegible]	[illegible]	0	127	96		
COM/IN	0	[illegible]	[illegible]	4	29	0		
INDUST	[illegible]	[illegible]	0	0	0	0	0	0
IND-RE	[illegible]	[illegible]						
IND-IN	[illegible]	[illegible]						
IND-C/	[illegible]	34						
EVAP-S	[illegible]							
EVAP-G	[illegible]							
FUEL-V	[illegible]	[illegible]	260	[illegible]	72	[illegible]		
AIRCRA	0	[illegible]	0					
VESSEL	0	0	[illegible]	117				
VEH-MI	0	0	0	0				

PROJECTED AREA DATA FOR STATE 1, COUNTY 2120

REGION	0	54	40	0	143	49		
COM/IN	0	[illegible]	71	12	59	0		
INDUST	[illegible]	72[illegible]	0	0	0	0	0	0
IND-RE	0	401						
IND-IN	[illegible]	[illegible]						
IND-C/	0	43						
EVAP-S	61							
EVAP-G	[illegible]							
FUEL-V	230[illegible]	35[illegible]3	115	27[illegible]	128	157		
AIRCRA	[illegible]	0	0					
VESSEL	[illegible]	0	[illegible]	58				
VEH-MI	0	0	0	0				

PROJECT AREA DATA FOR STATE 1, COUNTY [illegible]

RE[illegible]N	0	[illegible]	[illegible]	0	17	[illegible]		
COM/[illegible]N	0	0	[illegible]	2	4	0		
IN[illegible]	0	[illegible]	0	0	0	0	0	0
IN[illegible]	0	[illegible]						
IN[illegible]	[illegible]							
IN[illegible]	0	[illegible]						
EV[illegible]	[illegible]							
EVA[illegible]	9[illegible]							
FUEL-V	[illegible]	[illegible]	[illegible]	[illegible]	28	[illegible]		
AI[illegible]	0	[illegible]	[illegible]					
V[illegible]FL	0	[illegible]	0	[illegible]				
VE[illegible]	[illegible]	[illegible]	[illegible]	0				

PROJECT [illegible] DATA FOR STATE 1, COUNTY [illegible]

RE[illegible]	0	[illegible]	5	0	57	53		
COM/IN	0	0	[illegible]	[illegible]	21	0		
INDUST	0	44	0	0	0	0	0	0
IN[illegible]	[illegible]	[illegible]						
[illegible]	[illegible]							
IN[illegible]	0	[illegible]						
EV[illegible]	[illegible]							
[illegible]	[illegible]							
FU[illegible]-V	84[illegible]	[illegible]	15[illegible]	1109	52	[illegible]		
AI[illegible]RA	0	0	0					
VE[illegible]FL	0	0	0	0				
V[illegible]	0	0	0	0				

PRO[illegible] AREA DATA FOR STATE 1, COUNTY [illegible]

RE[illegible]N	0	[illegible]	24	0	437	88		
CO[illegible]IN	0	0	[illegible]	[illegible]	[illegible]	0		
IN[illegible]	0	[illegible]	0	0	0	0	0	0
IN[illegible]	0	[illegible]						
INC IN	0	[illegible]						
IN[illegible]	[illegible]	[illegible]						
EV[illegible]	[illegible]							
EVA[illegible]	11[illegible]							
[illegible]	[illegible]	[illegible]	374	7892	354	921		
[illegible]	7[illegible]	8144	651					
[illegible]	0	0	0	43				
VE[illegible]	0	0	0	0				

PROJECT [illegible] AREA DATA FOR STATE 1, COUNTY 2800

RE[illegible]EN	0	76	[illegible]	0	52	74		
COM/IN	0	0	[illegible]	6	20	0		
INDUST	0	[illegible]	0	0	0	0	0	0
INC[illegible]	0	[illegible]						
INC IN	0	7						
INC-[illegible]	0	[illegible]						

2 OF 2

PB

250680

[illegible]	[illegible]							
EVAP-C	[illegible]							
FUEL-V	[illegible]	[illegible]	[illegible]	1115	53	57		
AIRCRA	[illegible]	0						
VESSEL	0	0	[illegible]	0				
VT-M-MT	0	0	0	[illegible]				

PROJECTED AREA DATA FOR STATE 1, COUNTY 2320

RES/IN	[illegible]	[illegible]	12	3	101	73		
COM/IN	0	[illegible]	74	5	20	0		
INDUST	0	1[illegible]	0	0	0	0	0	0
INC-RE	0	[illegible]						
INC-IN	0	0						
INC-CM	0	[illegible]						
EVAP-S	9[illegible]							
EVAP-C	[illegible]							
FUEL-V	[illegible]	2[illegible]	114	2027	98	115		
AIRCRA	0	0	[illegible]					
VESSEL	0	0	0	13				
VT-M-MT	0	[illegible]	0	0				

PROJECTED AREA DATA FOR STATE 11, COUNTY 1000

RES/IN	0	[illegible]	1[illegible]	[illegible]	[illegible]	1		
COM/IN	0	0	9	10	28	0		
INDUST	0	0	0	0	0	0	0	0
INC-RE	12	3						
INC-IN	12	4						
INC-CM	5	3						
EVAP-S	[illegible]							
EVAP-C	[illegible]							
FUEL-V	[illegible]	[illegible]	224	1614	17	63		
AIRCRA	0	0	0					
VESSEL	0	0	0	0				
VT-M-MT	0	6191	0	9663				

PROJECTED AREA DATA FOR STATE 11, COUNTY 1720

RES/IN	0	[illegible]	1	0	19	22		
COM/IN	0	0	8	9	11	0		
INDUST	0	7	0	6	0	4	0	0
INC-RE	4	11						
INC-IN	0	0						
INC-CM	2	1						
EVAP-S	[illegible]							
EVAP-C	1							
FUEL-V	13814	723	238	666	14	75		
AIRCRA	0	0	0					
VESSEL	0	0	0	2				
VT-M-MT	0	2170	0	0				

PROJECTED AREA DATA FOR STATE 11, COUNTY 2520

REGION		[illegible]	[illegible]	[illegible]	16	[illegible]		
COM/IN		[illegible]	3	10	13	0		
INDUST	0	[illegible]	[illegible]	11	0	4	0	0
INC-RE	4	11						
INC-IN	5	2						
INC-CO	2	1						
EVAP-S	[illegible]							
EVAP-G	[illegible]							
FUEL-V	54[illegible]	[illegible]	[illegible]	778	17	0		
AIR-PA	[illegible]	0	[illegible]					
VEH-FL	0	0		0				
VEH-MI	0	[illegible]	0	7480				

PROJECTED AREA DATA FOR STATE 11, COUNTY 3580

REGION	0	[illegible]	[illegible]	0	3	17		
COM/IN	0	0	0	7	6	0		
INDUST	0	18	0	[illegible]	0	10	0	0
INC-RE	2	1						
INC-IN	0	0						
INC-CO	1	[illegible]						
EVAP-S	12							
EVAP-G	72							
FUEL-V	3207	[illegible]	39	727	7	0		
AIR-PA	0		0					
VEH-FL	0	0	0	0				
VEH-MI	0	4000	0	0				

PROJECTED AREA DATA FOR STATE 11, COUNTY 3360

REGION	[illegible]	49	[illegible]	0	446	3		
COM/IN	[illegible]	0	14	173	164	0		
INDUST	0	425	0	293	0	263	0	0
INC-RE	59	17						
INC-IN	98	75						
INC-CO	39	29						
EVAP-S	[illegible]							
EVAP-G	811							
FUEL-V	[illegible]	1779	2578	10726	242	60		
AIR-PA	[illegible]	[illegible]	329					
VEH-FL	0	0	0	0				
VEH-MI	0	48300	0	44210				

PROJECTED AREA DATA FOR STATE 11, COUNTY 4260

REGION	0	[illegible]	3	0	3	10		
COM/IN	0	0	5	7	2	0		
INDUST	0	4	0	17	0	2	0	0
INC-RE	1	2						
INC-IN	0	0						
INC-CO	1	0						
EVAP-S	5							
EVAP-G	18							

PROJECTED AREA DATA FOR STATE 11, COUNTY 4600

[illegible]	[illegible]	[illegible]	[illegible]		10	[illegible]		
[illegible]	[illegible]		[illegible]		[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	0	0
[illegible]	[illegible]	[illegible]						
INC-IN	0	0						
INC-CZ	2	1						
EVAP-[illegible]	17							
EVAP-C	[illegible]9							
FUEL-Y	495[illegible]	[illegible]	12[illegible]	425	10	200		
AIRCRA	[illegible]		[illegible]					
VEHICL	[illegible]	[illegible]	[illegible]	[illegible]				
VEH-MI	[illegible]	[illegible]	0	[illegible]				

PROJECTED AREA DATA FOR STATE 11, COUNTY 4700

PETRIN	0	[illegible]	[illegible]	0	43	29		
COMVIN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
INDUST	[illegible]	[illegible]	0	[illegible]	0	[illegible]	0	0
INC-[illegible]	[illegible]	[illegible]						
INC-IN	3	[illegible]						
INC-CZ	[illegible]	[illegible]						
EVAP-[illegible]	67							
EVAP-C	[illegible]							
FUEL-Y	[illegible]	[illegible]	[illegible]	[illegible]	3[illegible]	173		
AIRCRA	[illegible]		[illegible]					
VEHICL	[illegible]	[illegible]	[illegible]	0				
VEH-MI	0	[illegible]	[illegible]	70[illegible]				

PROJECTED AREA DATA FOR STATE 11, COUNTY 4780

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

PROJECTED AREA DATA FOR STATE 11, COUNTY 4360

PROJECTED AREA DATA FOR STATE 11, COUNTY 5480

RESID-FN	[illegible]	[illegible]	[illegible]	0	2	15	
COM/IN	[illegible]	[illegible]	5	[illegible]	2	[illegible]	
INDUST		[illegible]		[illegible]	[illegible]	[illegible]	0
INC-RE	[illegible]	2					
INC-IN	[illegible]	[illegible]					
INC-CA	1	[illegible]					
EVAP-S	5						
EVAP-G	[illegible]						
FUEL-V	[illegible]	137	59	151	3	78	
AIRCRA	[illegible]	[illegible]	[illegible]				
VEH-[illegible]		[illegible]	[illegible]	0			
VEH-MI	[illegible]	[illegible]	[illegible]	0			

END OF AREA RECORDS - [illegible]

[illegible] EMISSION SUMMARY

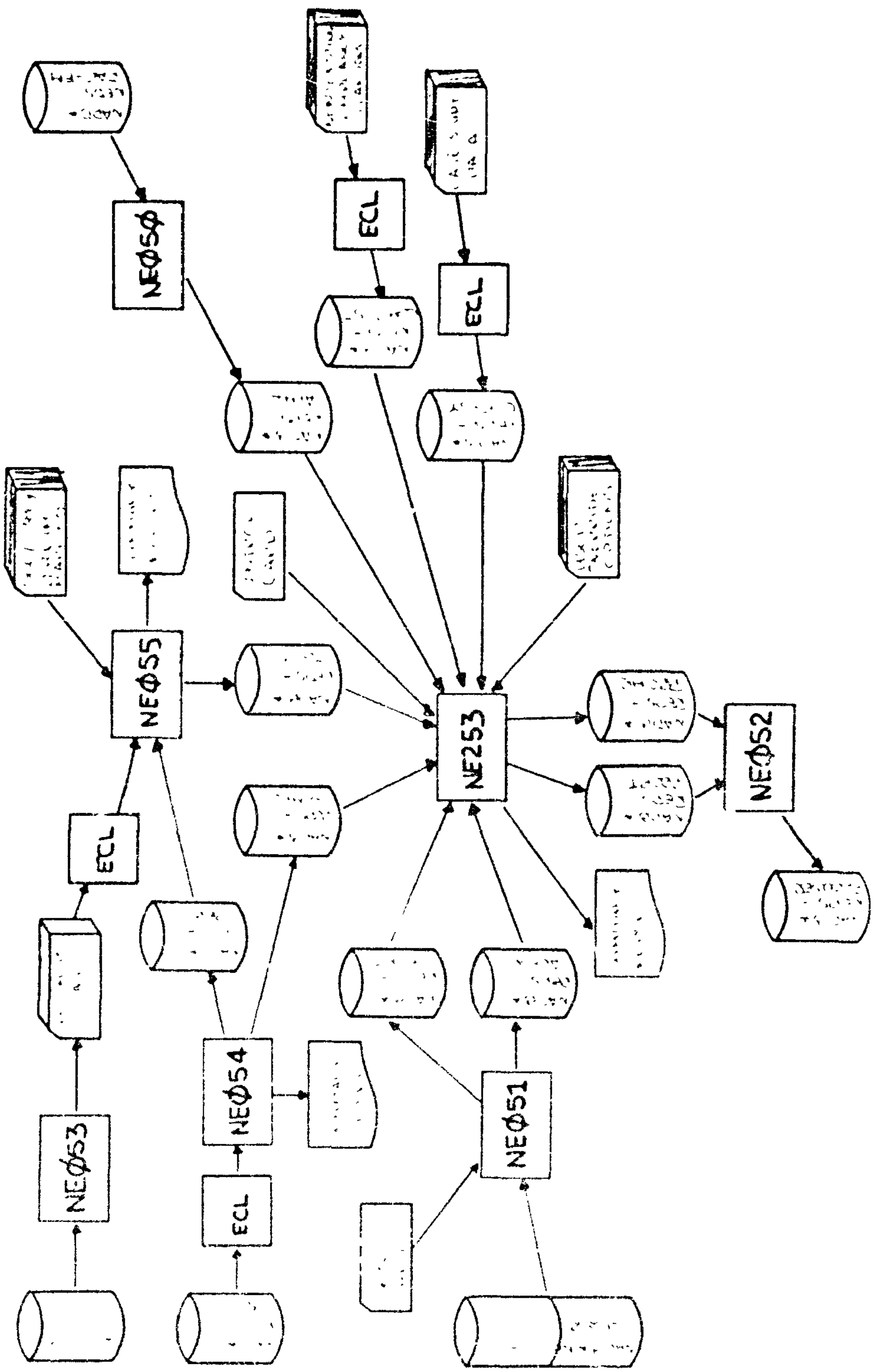
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	HC	CO	NUMBER
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	183372.	14.
	PROJECTION YEAR	[illegible]	[illegible]	[illegible]	[illegible]	133547.	
	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	BASE YEAR EMISSIONS	[illegible]	0.	0.	0.	0.	[illegible]
	PROJECTION YEAR	[illegible]	0.	0.	0.	0.	
	% CHANGE	[illegible]	.0	.0	.0	.0	
[illegible]	[illegible]	[illegible]	0.	0.	0.	0.	2.
	[illegible]	[illegible]	0.	0.	0.	0.	
	% CHANGE	[illegible]	.0	.0	.0	.0	
[illegible]	BASE YEAR EMISSIONS	[illegible]	[illegible]	0.	0.	1043037.	11.
	PROJECTION YEAR	[illegible]	[illegible]	0.	0.	1007110.	
	% CHANGE	[illegible]	[illegible]	.0	.0	-3.5	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.	0.	37.
	[illegible]	[illegible]	[illegible]	[illegible]	0.	0.	
	[illegible]	[illegible]	[illegible]	[illegible]	.0	.0	
[illegible]	[illegible]	[illegible]	0.	0.	0.	0.	1.
	PROJECTION YEAR	[illegible]	0.	0.	0.	0.	
	[illegible]	[illegible]	.0	.0	.0	.0	
[illegible]	[illegible]	[illegible]	[illegible]	0.	0.	0.	17.
	[illegible]	[illegible]	[illegible]	0.	0.	0.	
	[illegible]	[illegible]	[illegible]	.0	.0	.0	

III. DESCRIPTION OF REPS PROGRAM MODULES

The modules of the REPS system were identified in the previous chapter. Figure III-1, the general REPS system flowchart, shows the input-output relationships of those program modules. This chapter contains an abstract and a detailed description of each of these modules. This information appears exactly as given in the AEROS program documentation of the REPS system. Additional information concerning these modules can be found in the program documentation; the following topics are discussed for all program modules, in which the following:

- Module flow charts
- Input-output description
- Test data
- Operating instructions
- Suggestions, warnings and changes
- Program listing.

FIGURE III-1
General System Flowchart



1. PROGRAM NE053 (SEAS)

- ABSTRACT

The purpose of the FORTRAN program NE053 (SEAS) is to extract and process national economic growth projections from the input file and to write a file which contains those growth factors from 1974 to the year 2000. It is necessary to execute this program only when the INFORUM economic projections in the input file have been updated.

The input file is a standard output of the SEAS* system and was provided by EPA Washington. The SEAS projections are based on the INFORUM input-output econometric model. For further information consult the REPS design methodology presented earlier in this report, as well as the SEAS program documentation. The file contains projections of national total gross output for each INFORUM sector and subsector for the years 1971 to 1985 in one year increments, and reflects the "base case" SEAS scenario. In the absence of INFORUM projection data after this time period, growth for the period 1985 to 2000 for all sectors was assumed to be 3.8 percent per year. National output for an entire INFORUM sector is given in millions of 1967 dollars, and for subsectors within a sector, output is given in physical units. In either case dimensionless real growth can be computed. Sectors and subsectors in general are defined at the industry group (2 or 3 digit SIC) level.

Program NE053 performs three distinct operations:

- Locates records which contain the required data for the years 1974 (base year) through 1990
- Assigns data for each sector/subsector to a unique SEAS output section

---

* Strategic Environmental Assessment System, an econometric and emission forecasting model. The SEAS model was developed by the EPA Office of Research and Development, Washington, D. C.

- Calculates scalar growth (from the base year) ratios for each INFORUM sector and subsector.

The output file created by the program contains national growth ratios associated with each INFORUM sector for each projection year. This file is read by the program NE055 (MAP), which also reads the output file of program NE054 (OBERS) containing the growth in regional share for each of the 28 OBERS sectors for the same years.

- RUN DESCRIPTION

The INFORUM input file is a FORTRAN variable-length, fixed block file. It is recommended that the program remain at EPA Washington* because of the difficulty in reading IBM-generated, variable-length FORTRAN records on a UNIVAC system. The file contains 10 types of records:

- Record 1 - Header
- Record 2 - General sector and run description (Begin sets of 8 records, one set for each year's data)
- Record 3 - Miscellaneous data
- Record 4 - Consumer purchases sector
- Record 5 - Output sectors (dollars)
- Record 6 - Output subsectors (physical units)
- Record 7 - Net imports sectors
- Record 8 - Employment sectors
- Record 9 - Capital investment sector
- Record 10 - Construction sector.

* The program NE053 (SEAS) and the INFORUM input file are resident on the IBM 370/158 system located at Optimum Systems, Inc. (OSI), Bethesda, Md.

Out of the 10 record types, only two types are required for processing by the program. These are Records 5 and 6. Record 5, "Output Sectors" contains total gross output data (in constant dollars) for each INFORUM sector, while Record 6, "Output Subsectors," contains total gross output data in physical units (tons, Btu's, etc.) for each INFORUM subsector.

Only 9[illegible] of the 185 primary sectors and 99 subsectors produce air pollution emissions and thus have correspondence to an SCC process. Hence the SEAS program calculates growth ratios only for these sectors and subsectors. Table III-1 shows the sector number assigned in this program to each of the INFORUM sector-subsector combinations which correspond to SCC processes. This numbering system was developed for use internally by the modules of the REPS system. In this case the output sector codes are referenced by program NE055 (MAP).

Table III-1

INFORUM Sector Identification Matrix

Description	INFORUM Sector	INFORUM Subsector	REPS Sector (used internally)
Cotton	4	-	400
Phosphate Rock	9	9-02	902
Titanium Ore	9	9-03	903
Coal	14	-	1400
Indus. Combustion: Coal	14	14-01	1401
Oil, Petroleum, Gas	15,69,70	-	1599
Stone and Clay	16	-	1600
Meat	23	-	2300
Dairy	24	-	2400
Grain	26	-	2600
Sugar (Beet)	28	28-01	2801
Sugar (Cane)	28	28-02	2802
Candy	29	-	2900
Liquor	30	-	3000
Misc. Food	33	-	3300
Textiles	35,37,38,39,40	-	3599
Rugs	36	-	3600
Wood	41	-	4100
Millwork	43	-	4300
Furniture	45, 46	-	4599
Pulp	47	-	4700
Industrial Chemicals	55	-	5500
Chlorine	55	55-01	5501
Nitric Acid	55	55-02	5502
Hydrofluoric Acid	55	55-05	5505
Sulfuric Acid	55	55-06	5506
Phosphoric Acid	55	55-07	5507
Sodium Carbonate	55	55-08	5508
Fertilizer	59	-	5900
Pesticides	60	-	6000
Misc. Chemicals	61	-	6100
Carbon Black	61	61-01	6101
Plastic & Misc. Plastics	62, 74	-	6299
Plastic Material	62	-	6200
Rubber Products	63,72,73	-	6399
Synthetic Rubber	63	-	6300

Table III-1 (Continued)

Description	INFORUM Sector	INFORUM Subsector	REPS Sector (used internally)
Cellulose Fibers	64	-	6400
Non-Cellulose Fibers	65	-	6500
Cleaning Preparations	67	-	6700
Paint	68	-	6800
Gasoline	69	-	6900
Heating Oil	70	-	7000
Indus. Combustion: Oil	70	70-01	7001
Paving & Asphalt	71	-	7100
Tires & Inner Tubes	72	-	7200
Rubber Products	73	-	7300
Misc. Plastic Products	74	-	7400
Leather Prod.	75,76,77	-	7599
Glass	78	-	7800
Structural Clay	79	-	7900
Pottery & Other Clay	80,82	-	8099
Cement	81	-	8100
Other Clay	82	-	8200
Asbestos Products	82	82-01	8201
Primary Metals	83,84,85,86,87	-	8399
Steel	83	-	8300
Coking in Steel	83	83-01	8301
By-Product Coking	83	83-30	8330
Beehive Coking	83	83-31	8331
Basic Oxygen Furnace	83	83-32	8332
Electric Furnace	83	83-33	8333
Open Hearth Process	83	83-34	8334
Copper	84	-	8400
Copper Smelting	84	84-31	8431
Lead	85	-	8500
Zinc	86	-	8600
Aluminum	87	-	8700
Bayer-Hall Process	87	87-31	8731
Primary Non-Ferrous	88	-	8800
Mercury	88	88-02	8802
Beryllium	88	88-06	8806
Gold	88	88-09	8809
Molybdenum	88	88-11	8811

Table III-1 (Continued)

Description	INFORUM Sector	INFORUM Subsector	REPS Sector (used internally)
Non-Ferrous Rolling	89	-	8900
Non-Ferrous Casting	91	-	9100
Metal Cans	92	-	9200
Misc. Manufacturing	93-102,104-143	-	9399
Other Fabricated Metals	101	-	10100
Electric Utilities	160	-	16000
Electricity by Coal	160	160-01	16001
Electricity by Oil	160	160-02	16002
Electricity by Natural Gas	160	160-03	16003
Electricity: Low Sulfur Coal	160	160-30	16030
Electricity: High Sulfur Coal	160	160-31	16031
Electricity: Low Sulfur Oil	160	160-32	16032
Electricity: High Sulfur Oil	160	160-33	16033
Electricity: High Temp. Gas	160	160-34	16034
Electricity: Water Reactors	160	160-35	16035
Electricity: Gasified Coal	160	160-36	16036
Electricity: Natural Gas	160	160-37	16037
Process Spent Fuel Rods	160	160-38	16038
Natural Gas	161	-	16100
Indus. Combustion: Gas	16	161-01	16101
Water and Sewer Service	162	-	16200

2. PROGRAM NE054 (OBERS)

- **ABSTRACT**

The purpose of the FORTRAN program NE054 (OBERS) is to extract, sort and condense the OBERS economic projections* for AQCRs and to write two files which contain regional growth projection data in a more convenient and efficient format, to be read by later programs (NE055 and NE253). It is necessary to execute the program only when the OBERS projections are modified, and not every time the REPS system is exercised.

The input file, NADB REPS-OBRS-IN., which contains the OBERS projection data provided by the U.S. Department of Commerce, contains the following data categories for each AQCR:

- Earnings by each of 28 OBERS industrial sectors (in 1967 dollars)
- Midyear population
- Total personal income (in 1967 dollars)

These data are given for the years 1970 to 2000 in 5 year increments, (data are also included for 1962, 1968, and 1969, but are not used by the program). The program performs four distinct operations:

- Correction for any data incomplete or missing from the projections (because of proprietary disclosures)
- Linear interpolation for intervening years
- Calculation of dimensionless growth factors referenced to the base year
- Calculation of growth factors for population and for employment for the commercial/institutional and military

---

* Regional economic projections developed by the U.S. Department of Commerce and Agriculture. For information consult the REPS design methodology presented earlier in this report.

sectors. The latter are based on regional earnings projections for these sectors, and national ratios of employment to earnings for these sectors.

Three output files are created by the program, two permanent and one temporary. One of the two permanent files contains regional base year data and projected growth factors for commercial/institutional employment, military employment, population, and personal income. This file is REPS-GEMPL, and the data it contains are referred to in the program documentation as "regional growth in employment." This file is read directly by the REPS program. The other permanent output file contains regional earnings for each of the 28 OBERS industrial sectors, and growth factors reflecting the projected regional change in share relative to national earnings forecasts. This file is read by the program NE055 (MAP), which also reads the national earnings forecasts from SEAS and produces projection growth factors for each OBERS sector to be used by the REPS program. The temporary file is created to store data read by the program from the OBERS input file for later use by the program. This file may be scratched after execution of NE054 (OBERS) program is complete.

- RUN DESCRIPTION

There are two distinct phases of this program. During the first phase the projections for earnings, population and personal income are read from the input file and are accumulated over all AQCRs to produce national projections for each year. Each record is processed and only those data which will be needed by the program during its second phase are written on a temporary storage file. During the second phase of the program the temporary file is read and the regional growth factors for each industrial sector in each AQCR are computed in sequence. The permanent output files are written after all the data for a given AQCR have been developed.

The output data stored on the permanent file later read by REPS consist of the following:

- National population, personal income, commercial/institutional employment and military employment for all years
- For each AQCR, growth factors for each of the above variables for each projection year, defined as (future level)/(base year level).

The output data stored on the permanent file later read by MAP consist of the following:

- National earnings data for each OBERS sector for base year and projection years
- For each AQCR, factors reflecting the regional shift in share of national earnings forecasts defined as:

$$\frac{\text{(projected regional earnings)/(projected national earnings)}}{\text{(base year regional earnings)/(base year national earnings)}}$$

Table III-2 shows for each of the 28 OBERS sectors the Department of Commerce code (by which the projection data are indexed on the input file), and the REPS sector number used internally by REFS system modules. These sector numbers (by which the data referenced in the MAP program) are assigned in this program.

Table III-2

OBERS Sector Identification Matrix

Department of Commerce Sector	Description	REPS Sector (used internally)
8110	Agriculture	1
8120	Forestry & Fisheries	2
8231	Metal	3
8210	Coal	4
8220	Crude Petroleum & Natural Gas	5
8232	Nonmetallic, Except Fuels	6
8300	Contract Construction	7
8410	Food & Kindred Products	8
8420	Textile Mill Products	9
8430	Apparel & Other Fabric Products	10
8460	Lumber Products & Furniture	11
8491	Paper & Allied Products	12
8440	Printing & Publishing	13
8450	Chemicals & Allied Products	14
8492	Petroleum Refining	15
8493	Primary Metals	16
8494	Fabricated Metals & Ordnance	17
8471	Machinery, Excluding Electrical	18
8472	Electrical Machinery & Supplies	19
8481	Motor Vehicles & Equipment	20
8482	Trans. Equip., Excl. Motor Vehicles	21
8495	Other Manufacturing	22
8500	Trans., Commun. & Public Utilities	23
8600	Wholesale & Retail Trade	24
8700	Finance, Insurance & Real Estate	25
8800	Services	26
8910	Civilian Government	27
8920	Armed Forces	28

3. PROGRAM NE055 (MAP)

- **ABSTRACT**

The FORTRAN program NE055 (MAP) combines econometric growth projections from the NE053 (SEAS) and NE054 (OBERS) programs to produce regional growth factors from 1974 to 2000 for each SCC, and creates a mass storage file containing a list of all SCC codes and the corresponding regional growth factor. The main element of this program is a mapping table which contains the SEAS and OBERS sector numbers corresponding to each of approximately 350 SCC codes. The regional growth factor for each SCC is computed from the growth in national total gross output (as given by NE053) and the shift in regional share (as given by NE054).

Program NE055 (MAP) is a module in the static subsystem of the REPS system; due to the nature of the data it uses and creates the program must be executed only when one or more of the following conditions occur:

1) Execution of the OBERS program of the REPS system is required due to creation of a new Department of Commerce (OBERS) regional earnings projection. (The next DOC update of the OBERS projections is scheduled for 1978.) The NE055 program must then be run to update the REPS regional growth factors.

2) Execution of the NE053 program of the REPS system is required due to update of the INFORUM econometric model, resulting in updated SEAS projections of national economic growth. The NE055 program must then be run to update the REPS regional growth factors.

3) Additions, deletions or corrections of the SCC-OBERS-INFORUM sector mapping matrix would necessitate a rerun of the MAP program.

- **RUN DESCRIPTION**

In order to relate the INFORUM and OBERS economic projection data to emission oriented SCC processes, a comprehensive mapping of sector relationships was developed. Since the sector definitions for the INFORUM and OBERS systems are SIC oriented, the methodology for creating a cross-index or map from one system to the other involved a rather simple comparison of the SIC categories included in each sector. While in most cases the mapping involved aggregating a number of INFORUM sectors to form one OBERS sector, there are a few cases where the INFORUM sector is mapped to two or more OBERS sectors. This difficulty inherent in the inverted mapping was overcome by aggregating the OBERS sectors to a level which no longer requires disaggregation of an INFORUM sector. Two examples of situations in which the approach was used are the OBERS sectors for Agriculture and Forestry-Fisheries, which were aggregated to form one OBERS sector so that INFORUM sectors 08 and 10 would not have to be disaggregated.

The sector definitions for INFORUM and OBERS economic projection data are given previously in Tables III-1 and III-2. Table III-2 shows for each of the 28 OBERS sectors the Department of Commerce code (by which the projection data are indexed on the OBERS input file) and the REPS sector number used internally by the REPS system. These sector numbers (by which the data are referenced in the MAP program) are assigned in program NE054. Table III-1 shows the INFORUM sectors and subsectors which are associated with air pollution emissions, and for each sector-subsector combination the REPS sector number used internally by the REPS system. These sector numbers (by which the data is referenced in the MAP program) are assigned in program NE055. Note that, when the two rightmost digits of the output sector are 99, the output sector represents an aggregation of two or more INFORUM sectors or subsectors.

In order to determine the projected growth in gross national product originating and the shift in regional share for each SCC process, relationships among INFORUM and OBERS economic sectors and all SCC processes were developed. This mapping or cross-index is given in Table III-3. The INFORUM and OBERS sector designations shown in Table III-3 are those which were defined in Tables III-1 and III-2, respectively, to be used internally by modules of the REPS system.

The NE075 (MAP) program uses the relationships in Table III-3 to compute, for each SCC and for each projection year, a growth factor which reflects both projected national growth (from INFORUM) and projected shift in each region's share of that national growth (from OBERS). A complete description of the methodology utilized in the REPS system to compute these growth factors is given earlier in this report.

Table III-3

INFORUM-OBERS-SCC Mapping Matrix

SCC	OBERS	INFORUM
10100199	23	16001
10100299	23	16001
10100399	23	16001
10100499	23	16002
10100599	23	16002
10100699	23	16003
10100799	23	16003
10100899	23	16001
10101199	23	2600
10101299	23	16001
10200199	22	1401
10200299	22	1401
10200399	22	1401
10200401	22	7001
10200403	22	7001
10200499	22	7001
10200502	22	7001
10200599	22	7001
10200601	22	15101
10200603	22	15101
10200699	22	15101
10200799	22	15101
10200899	22	1401
10200902	22	4100
10200999	22	4100
10201099	22	15101
10201199	22	2600
10300199	20	1401
10300299	20	1401
10300399	20	1401
10300499	20	7001
10300599	20	7001
10300699	20	16101
10300999	20	4100
10301099	20	15101
20100199	23	15002
20100299	23	15003
20100399	23	15002
20200199	22	7001
20200299	22	15101
20200399	22	16101
20200499	22	15101
20300199	20	16101
20400199	20	7001
20400299	20	7001
30100199	14	5500
30100299	14	5500
30100399	14	5500
30100499	14	5500
30100505	14	5101
30100599	14	5101
30100699	14	5100
30100799	14	5501
30100899	14	5501
30100902	14	6700
30100999	14	6700
30101099	14	6100
30101199	14	5500
30101299	14	5500
30101399	14	5502
30101499	14	5800
30101599	14	5300
30101699	14	5507
30101799	14	5507
30101899	14	5200
30101999	14	5200
30102099	14	5100
30102199	14	5509
30102299	14	5506
30102399	14	5500
30102499	14	5500
30102599	14	5400
30102699	14	5309
30102799	14	5900
30102801	14	5900
30102899	14	5900
30102999	14	5900
30103099	14	5900
30103199	14	5500
30103299	14	5500
30103399	14	5000
30103499	14	5500
30103599	14	5500
30103699	14	5500
30103799	14	5500
30103899	14	5500
30103999	14	5500
30104099	14	5900
30105099	14	5100
30109099	14	5239
30109199	14	5100
30110099	14	5500
30110199	14	5300
30111099	14	5500
30111199	22	2001
30130099	14	5100
30139999	14	5500
30200199	9	2000
30200299	9	7300
30200399	9	7300
30200401	1	400
30200402	1	400
30200403	1	400
30200499	1	400
30200599	9	2600
30200699	9	2600
30200701	9	2600
30200799	9	2600
30200899	9	2600
30200999	9	7000
30201099	9	7000

Table III-3 (Continued)

30201199	9	7000
30201299	9	2300
30201399	9	2300
30201499	9	7600
30201599	9	7801
30201699	9	[illegible]
30201799	9	7300
30201899	9	7500
30203099	9	7400
30209999	9	2000
30300099	15	9700
30300199	10	9771
30300299	15	9700
30300399	15	9320
30300499	15	9331
30300599	15	9471
30300699	15	8374
30300799	15	9372
30300899	15	9300
30300999	15	9300
30301002	16	9500
30301099	15	9500
30301199	15	9811
30301299	15	307
30301399	15	9300
30301499	15	9900
30301599	16	9200
30302599	10	9000
30302699	15	9300
30303099	16	9600
30309999	10	9300
30400199	15	9700
30400299	15	9400
30400301	16	9300
30400399	15	9300
30400403	16	9500
30400499	15	9500
30400599	15	9500
30400699	16	9400
30400799	15	9300
30400899	15	9500
30400999	15	[illegible]
30401099	15	9400
30401199	15	9900
30402099	15	9100
30405099	15	9100
30409999	15	9200
30500199	15	7100
30500201	15	7100
30500202	15	7100
30500299	15	7100
30500399	22	7900
30500499	22	9200
30500599	22	9100
30500699	22	9100
30500799	22	9100
30500899	22	9200
30500999	22	9200
30501099	4	1400
30501101	22	9100
30501199	22	9100
30501299	22	9200
30501399	22	9200
30501401	22	7900
30501499	22	7800
30501599	22	9100
30501601	22	9100
30501699	22	9100
30501799	22	9200
30501899	22	9200
30501999	22	300
30502001	22	9200
30502002	22	9200
30502004	22	9200
30502005	22	9200
30502007	22	9200
30502099	22	9200
30502199	22	9200
30502299	22	9200
30502399	22	9200
30502499	22	9200
30502501	5	1000
30502599	5	1000
30502699	22	9200
30503099	22	9099
30503199	5	1001
30503299	22	9201
30504099	22	9200
30509999	22	9200
30600199	15	1599
30600299	15	1599
30600399	15	1599
30600499	15	1599
30600599	15	1599
30600699	15	1599
30600799	15	1599
30600899	15	1599
30600999	15	1599
30601099	15	1599
30601199	15	1599
30601299	15	1599
30601399	15	1599
30609999	15	1599
30700199	12	4700
30700299	12	4700
30700499	11	4300
30700599	11	4300
30700699	11	4300
30700799	11	4300
30700899	11	4100
30700999	11	4100
30701099	11	4300
30702099	11	4300
30709999	11	4300

Table III-3 (Continued)

30900199	16	9300
30901099	17	10100
30902099	17	9200
30903099	17	9399
30939999	17	9399
32099999	22	7599
33000199	9	7599
33000299	22	7300
33000399	9	7600
39000199	0	0
39000201	22	9100
39000203	22	9100
39000204	22	8200
39000206	22	7900
39000207	6	1600
39000208	14	1400
39000209	6	1500
39000299	0	0
39000401	22	9200
39000402	22	9100
39000403	22	9100
39000404	22	9200
39000405	16	9399
39000406	22	7900
39000407	6	1600
39000408	22	7300
39000409	6	1500
39000410	14	5100
39000411	22	9200
39000430	8	7600
39000431	8	7600
39000432	14	5900
39000450	11	4300
39000451	11	4300
39000499	0	0
39000501	22	9200
39000502	22	9100
39000503	22	9100
39000504	22	9200
39000505	16	9399
39000506	22	7300
39000507	6	1600
39000508	22	7900
39000509	6	1500
39000510	14	5100
39000511	22	9200
39000530	8	7600
39000531	8	7600
39000532	14	5900
39000550	11	4300
39000551	11	4300
39000599	0	0
39000601	22	9200
39000602	22	9100
39000603	22	9100
39000604	22	9200
39000605	16	9399
39000606	22	7300
39000607	6	1600
39000608	22	7900
39000609	6	1500
39000610	14	5100
39000611	22	9200
39000630	8	7600
39000631	8	7600
39000632	14	5900
39000650	11	4300
39000651	11	4300
39000699	0	0
39000701	16	9399
39000799	0	0
39000801	22	9200
39000899	0	0
39000999	0	0
40100199	26	5700
40100299	26	5700
40200199	14	5800
40200399	14	5000
40200499	14	5000
40200599	14	5300
40200699	14	5300
40200899	14	5800
40200999	14	5000
40300199	26	1599
40300299	26	1599
40300399	26	1599
40400199	14	5500
40500199	26	5500
40600199	16	1599
40600299	16	1599
40600399	16	1599
40600499	16	1599
43099999	16	1599
50100199	27	10200
50100299	27	10200
50100399	27	10200
50130099	27	10200
50200199	27	10200
50200399	27	10200
50200599	27	10200
50200099	27	10200
50300199	27	10200
50300299	27	10200
50300399	27	10200
50300499	27	10200
50300599	27	10200
50300699	27	10200
60199999	27	10200

4. PROGRAM NE050 (AP-42)

- <u>ABSTRACT</u>

The purpose of the COBOL program NE050 (AP-42) is to convert the NEDS Emission Factor file to field data format. In addition, it also reduces each 603 character record to an 80 character record. The program, part of the static system, was first executed for the initial creation of the REPS Emission Factor file. Subsequent runs of the program are necessary only if an update to the master NEDS Emission Factor file has taken place.

- <u>RUN DESCRIPTION</u>

The COBOL program NE050 (AP-42) converts the NEDS Emission Factor file to field data and reduces each 603 character record to an 80 character record. The resulting file contains the SCC value and the emission factors for the five criteria pollutants. The program consists of two components, a COBOL main program and a FORTRAN subroutine. The main program reads the COBOL-oriented input file and passes the necessary data to the subroutine (NEA050), which writes the reduced record in field data format, readable by the REPS System. The program need only be executed when the NEDS Emission Factor file is updated; in that case the entire Emission Factor file must be read as input by program NE050.

5. PROGRAM NE051 (NEDS-IN)

- ABSTRACT

The COBOL program NE051 (NEDS-IN) extracts, reduces and converts into field data those NEDS-USER file point and area source records which match the region code (AQCR, state or nation) specified in the program run control card. Each resulting output record contains abbreviated NEDS emission inventory data in a form readable by the FORTRAN program NE253 (REPS).

- RUN DESCRIPTION

Currently the NE051 (NEDS-IN) program is designed to process only one geographic region at a time, either the nation as a whole, a state, or an AQCR. If a number of regions are to be processed this program must be run once for each different region.

The program contains three major components. One is a COBOL main routine which reads the entire NEDS-USER file, tests the geographic region of the NEDS records for acceptance, and passes control and the necessary data fields to the appropriate FORTRAN subrountines. The other components are two subroutines, one for point records (NEB051) and one for area records (NEA051), which merely write the passed data in the output file as emission inventory records which contain NEDS data in a format compatible with program NE253. The order of area source output records corresponds to the order in which the input records were read, while the point source records are sorted by SCC code first and then are written in the output file.

6. PROGRAM NE253 (REPS)

- **ABSTRACT**

Program NE253 (REPS module) is the nucleus of the entire emission projection system. The relationship of this program to the rest of the system is illustrated in the next section (Flow Charts). Following all necessary initializations, the program locates all required growth factors and modifies these as required to reflect user supplied data. Each point source and area source record is then read, and activity and net emissions are calculated for the projection year. The program writes an output file containing the projected records (these are converted to NEDS-USER file format by program NE052) as well as a summary report containing a complete documentation of all assumptions and postulations used in computing the emission projections.

- **RUN DESCRIPTION**

The FORTRAN program NE253 (REPS module) consists of a main program and five subroutines. The following section deals with the main program; and that is followed by a discussion of the subroutines.

1. Main Program

The REPS main program contains essentially all of the I/O commands for the REPS module. The reduced NEDS-USER file is read one record at a time along with any of the miscellaneous data files which may be required to process that record. Based on the type of record, the program will call the appropriate subroutine for the actual projection calculations. The data which are passed to the subroutine contain the key base year NEDS data required in the projection equations in addition to the growth factor for that year. Control is then returned to the main program section to write the updated projection NEDS records. The cycle is then repeated until all records are processed. Currently the program is set up to "loop" back for processing of another region or a different projection year for the same region.

The flow of information through the REPS "Main", as in the five subroutines, is essentially sequential through all program statements as they appear in the program listing, except for minor branching to miscellaneous read and write error routines. Comment cards appearing throughout the program listing give very concise explanations of the function of each section and subsection.

The REPS "Main" program is divided into five functional sections. Duplication of some of the programming statements, necessary to make each section independent of the others, was done to facilitate understanding of the program listing. These five sections are as follows:

- Initialization Section
- NEDS Point Processing Section
- NEDS Area Processing Section
- Error Messages & Formats Section
- Final Statistical Section.

The following paragraphs describe the operation of these sections:

- Initialization Section: This section is executed once, at the beginning of the run; its purpose is to perform all necessary functions preliminary to the processing of point and area source emission records. First the run control card, which contains the projection year and AQCR, is read. Then all user supplied data is read and stored. All miscellaneous input files containing AQCR specific data are read to locate the file segments containing data for the AQCR specified on the run control card. Finally, the emission inventory files are read to obtain data for calculating the fuel use and base year Btu demand for each customer category (in subroutine NEA253 (BTUCAL)). This data is also used later in computing future Btu demand in subroutine COMBUS.

- NEDS Point Processing Section: In this section the reduced NEDS point records (sorted by SCC previously in the NEDS-IN module) are read sequentially and emissions are projected for one record at a time.

Projection data are obtained from the different input files by matching their SCC value to the SCC of the NEDS record. At least a six-digit SCC match is required at all times. Growth factors are obtained and recalculated if an override option was exercised. (A summary of available user options and overrides are discussed in detail later in this section.) Based on the first digit of the SCC of the NEDS record, control is passed to the appropriate point source subroutine for the actual project in calculations. (There are six such subroutines or entry points; the first digit of the SCC must be between 1 and 6.) Description of the variables that are passed are given later in this section. After the emissions have been projected, control is returned to the "Main" program and the updated projection record is written. Then another NEDS point record is read, and the cycle is repeated. At the end of the file of point source records, control is passed to the NEDS Area Section.

- NEDS Area Processing Section: In the initial series of statements all area source growth factors are calculated prior to reading the first reduced NEDS area record. Then the two area projection subroutines are called in series, one for transportation activity projections and the other for non-transportation activity projections. Control is then passed back to "Main" for writing the area projection records. Another area record is read and the process is repeated. At the end of the file of area source records, control is passed to the Final Statistical Section.

- Error Messages and Format Section: This section contains all write and format statements for any error messages, and is accessed from any other section only to print out error messages. Descriptions of some of the key error messages are included in Section 6.

- Final Statistical Section: This section prints summary results of the run. These include:

- Record count by SCC type
- Percent change in emissions from base year to projection year for emission source categories (each source category contains all SCCs for which the first three digits are identical)
- Percent change in area activity from the base year to the projection year
- Emissions by transportation vehicles.

2. Subroutines

The five subroutines of program NE253 (REPS module) are described in this section.

- NEA253: This subroutine (BTUCAL) is executed only once, at the beginning of the REPS "Main" program. It generates the Btu ratios for each fuel type for those point records which contain fuel use data. The Btu ratios are computed for each customer category as the Btus consumed for each fuel divided by total Btus consumed for all fuels. In addition to generating the Btu ratios, the subroutine calculates growth factors for each fuel type within each customer category based on projected Btu demand for each customer category.

The four remaining subroutines include two for point source projections and two for area source projections. There are a total of seven entry points to the point source processing subroutines, and a total of two entry points to the area source processing subroutines.

- NEB253: This subroutine (COMBUS) calculates the projected point source emissions for those records in which emissions were the result of fuel combustion, or solid waste disposal. It accesses informa-concerning base year fuel use and Btu demand for each customer category, which was calculated in the subroutine BTUCAL.

- NEC253: This subroutine (INDPRC) calculates the projected emissions for those point records in which the emissions were the result of industrial processes, evaporation, or miscellaneous point sources.

- NED253: This subroutine (AREASC) is called to calculate projected increase in non-transportation activity for area records.

- NEE253: This subroutine (TRANS) is called to calculate projected increase in transportation activity.

Table III-4 contains a summary of information concerning entry to the five subroutines. For each individual entry point, the subroutine containing the entry point is given, as well as the type of NEDS record which is processed (point or area), and the criteria used in the "Main" program to branch to the given entry point.

The REPS system is complete and autonomous to the extent that the program contains all the data required to project a complete emission inventory. However, provision is made in the system for extensive override of this data with alternate data supplied at the option of the user. These user supplied data can be divided into two types:

- Data which affect the projected change in activity levels (growth factors)

- Data which affect projected emissions by altering or supplementing the base year emission inventory data.

Instructions for entering user-supplied data into the REPS system are given in Section 5 of the documentation for this module. Figure III-2 contains, for each emission producing activity category, the available user overrides of the first type, together with the factors which are used by the program to project activity in the absence of user overrides.

User supplied data to override SCC-specific growth factors are read by the program from the NADB-REPS-COMP-ST file; all other override data reference in Figure III-2 are read from the "user override options" card input.

Table III-4

Subroutine Entry Points and Entry Criteria

Entry Point Name	Subroutine Containing the Entry Point	Type of NEDS Record	Criteria for Branching to the Entry Point
COMBUS	NEB253	Point Records	- Initialization of the subroutine
BTUCAL	NEA253	Point Records	- Calculation of Btu's per fuel for those records whose 1st position of the SCC equals 1, 2, or 5
EXTCMB	NEB253	Point Records	- Calculation of emissions for external combustion records (1st position of the SCC = 1)
INTCMB	NEB253	Point Records	- Calculation of emissions for internal combustion records (1st position of the SCC = 2)
INDPRC	NEC253	Point Records	- Calculation of emissions for industrial processes point sources (1st position of the SCC = 3)
EVAPT	NEC253	Point Records	- Calculation of emissions for evaporation point sources (1st position of the SCC = 4)
SLDWST	NEB253	Point Records	- Calculation of emissions for solid waste point sources (1st position of the SCC = 5)
MISPT	NEC253	Point Records	- Calculation of miscellaneous point emissions (1st position of the SCC = 6)
AREASC	NED253	Area Records	- Calculation of projected increase for all non-transportation area activities
TRANS	NEE253	Area Records	- Calculation of projected transportation area activities related

FIGURE III-1
Projection Factors and User Overrides

FACTORS USED TO PROJECT FUTURE ACTIVITIES AND EMISSIONS	BASE LINE FACTORS	USER REPLACEMENT OF BASE LINE FACTORS	USER SUPPLIED ADDITIONAL FACTORS* (E.G. GROWTH & RATIOS)	POINT SOURCES: EXTERNAL COMBUSTION	POINT SOURCES: INTERNAL COMBUSTION	POINT SOURCES: INDUSTRIAL PROCESS	POINT SOURCES: EVAPORATION	POINT SOURCES: SOLID WASTE	POINT SOURCES: MISCELLANOUS SOURCES	AREA SOURCES: RESIDENTIAL FUELS	AREA SOURCES: COMM INST FUELS	AREA SOURCES: INDUSTRIAL FUELS	AREA SOURCES: SOLID WASTE RESIDENTIAL	AREA SOURCES: SOLID WASTE COMM INST	AREA SOURCES: SOLID WASTE INDUSTRIAL	AREA SOURCES: EVAPORATION LOSSES	AREA SOURCES: MOTOR VEHICLE FUELS	AREA SOURCES: AIRCRAFT LTOS	AREA SOURCES: VESSEL FUELS
[illegible]	(1)	(6)		●	●	●	●	●	●										
[illegible]	(1)	(6)								●	●	●	●			●	●	●	
[illegible] CIVILIAN EMPLOYMENT	(2)	(6)		●	●									●					
[illegible] PRODUCT [illegible]	(2)	(6)													●				
[illegible] RATIO POINT [illegible]	(1)	(6)		●	●			●											
[illegible] AREA	(3)		(6)							●	●	●	●	●	●				
[illegible]	(4)		(6)							●									
[illegible] EMISSION FACTORS	(4)																●		
PORT AUTHORITY GROWTH	(4)	(6)																	●
TRANSPORTATION GROWTH AND [illegible]			(6)														●		

(1) SOURCE: NA [illegible] EPS TGOS
(2) SOURCE: NA [illegible] REPS [illegible]
(3) SOURCE: INTERNALLY COMPUTED BASED ON NADB* NEDS USER
(4) SOURCE: INTERNALLY COMPUTED CONSTANTS
(5) SOURCE: NA [illegible] REPS [illegible]
(6) SOURCE: CONTROL CARD USER OVERRIDES

*FACTORS WHICH SUPPLEMENT RATHER THAN OVERRIDE THE BASELINE FACTORS

The second type of user supplied data affects projected emissions by altering the base year emission inventory data on which the projections are based. This type of user supplied data includes:

- Required control efficiency for sources governed by new source standards
- Required control efficiency for sources governed by existing source standards
- New point sources expected to be operating during the projection year which were not entered in the NEDS file and which were not included in the Case Study input data.[*] (The NEDS file contains some data on plants to become operational in the future).

User supplied control efficiency is read by the program from the REPS-COMPT-ST file; any new point source data is included with the Case Study card input.

---

[*] The Case Study is a special analysis of growth and relocation trends for five industries which are among the heaviest industrial polluters. These critical industries include electric power generation, steel, chemicals, pulp manufacturing and petroleum refining. The output of this analysis was a file of data on new plants expected to become operational in the future, which is read by the REPS module as card input at the user's option.

7. SUBROUTINE NEA253 (BTUCAL)

- ABSTRACT

The subroutine NEA253 (BTUCAL) is executed only once, at the beginning of the REPS "Main" program. It generates the Btu ratios for each fuel type for those point records which contain fuel use data. The Btu ratios are computed for each customer category as the Btus consumed for each fuel divided by total Btus consumed for all fuels. In addition to generating the Btu ratios, the subroutine calculates growth factors for each fuel type within each customer category based on projected Btu demand for each customer category. Unlike the other subroutines in the NE253 program, NEA253 pre-reads the NEDS point source records along with the Emission Factor file and the SCC growth factors. The resulting matrices are passed to the "Main" program via the CALL statement.

- RUN DESCRIPTION

The processing sequence of the NEA253 subroutine is as follows. Net base year emissions from fuel combustion are first converted to uncontrolled emissions using base year control efficiency information. These data are then converted to fuel usage based on emission factors from the Emission Factor file and finally converted to Btu equivalents using an internal matrix (Table III-5). The Btu totals by fuel type and by SCC classification are used to produce the Btu ratios for the base year. Growth factors for each SCC are computed using the base year Btu ratios, the expected growth in Btu demand and the fuel mix for the projection year.

Table III-5
Btu Conversion Table

Fuel Type	Btu's (10^3) per Unit Burned
Coal:	
Bituminous coal	26.2/ton
Anthracite coal	25.4/ton
Coke	24.8/ton
Solid waste w/coal	23.9/ton
Lignite coal	14.8/ton
Gas:	
Natural gas	1050.0/cu ft
Process gas	145.0/cu ft
Oil:	
Residual oil	150.0/gal
Distillate oil	140.0/gal
Diesel	138.0/gal
Gasoline	125.0/gal
Aviation fuel	120.0/gal
Miscellaneous:	
Liquid petroleum gas	94.0/cu ft
Wood (dry)	19.5/cu ft
Bagasse	17.0/cu ft

Sixty percent coal and forty percent solid waste.

8. SUBROUTINE NEB253 (COMBUS)

- ABSTRACT

The subroutine NEB253 (COMBUS) computes projected emissions for external and internal combustion and solid waste point sources. The subroutine is passed base year emissions and associated data from the main program NE253 (REPS) and returns net emissions and associated data for the projection year in the same data format. The projected emissions include the effect of control regulations already in effect as well as performance standards which will become effective in the future. There is provision for user override of all the factors used to project future fuel use and net emissions.

- RUN DESCRIPTION

The processing routines are identical for external and internal combustion and solid waste point source emissions. All input and output data are passed through common storage and the subroutine argument list. The data passed through common storage includes net emissions, control efficiency, allowable emissions, and compliance information for the base year from the NEDS file. Also passed are all necessary data on control regulations and projected growth.

There are two types of user-supplied control regulations affecting future point source emissions. One type affects only new equipment which becomes operational after the effective date of the regulation. These regulations are referred to in this section as new source standards. The other type of regulation is either in effect in the base year or will be in effect before the projection year, and governs both existing and new facilities. These regulations are referred to in this section as existing source standards.

The processing sequence to project fuel combustion emissions is as follows. Net base year emissions are converted to uncontrolled emissions (using the base year control efficiency) and to fuel use (using emission factors read from the emission factor file). Fuel use for each customer category is converted to equivalent base year Btu demand; SCC-specific growth factors are used to forecast the future Btu demand, which is allocated to fuels based on the expected fuel mix in the projection year. Uncontrolled emissions are then computed using the emission factors. Emissions from solid waste disposal are projected in the same general way, except that the amount of solid waste burned, rather than the Btu demand, is projected for each customer category, and the projected tonnage is allocated to disposal methods in the same way that future fuel mix is used to allocate the projected Btu demand.

This approach produces one of the following types of output records:

- When no control standards are supplied: one record with emissions controlled by the base year control efficiency
- When only new source standards are given: one record with emissions which are affected by the base year control efficiency and one record with emissions which are affected by the new source standards
- When both existing and new source standards are given: one record with emissions which are affected by the existing standards and one record with emissions which are affected by the new source standards.

Thus one or two output records may be produced for each input record.

The next step in the processing sequence involves reducing the projected emissions if the projection year follows the expiration date of a variance and if projected emissions exceed the allowable emissions from which the variance was granted. Variance information and allowable emissions are included in the NEDS emission inventory data.

Projected emissions are finally returned through common storage to the main program.

9. SUBROUTINE NEC253 (INDPRC)

- ABSTRACT

The subroutine NEC253 (INDPRC) computes projected emissions for industrial process, evaporation and miscellaneous point sources. The subroutine is passed base year emissions and associated data from the main program NE253 (REPS) and returns net emissions and associated data for the projection year in the same data format. The projected emissions include the effect of control regulations already in effect as well as performance standards which will become effective in the future.

The general projection methodology, presented earlier in this report, involves converting net base year emissions to uncontrolled emissions, forecasting equivalent uncontrolled emissions in the projection year, and then estimating projected net emissions as affected by emission control regulations. The methodology is based on the fundamental assumption that uncontrolled emissions are proportional to emission-producing activity (e.g., plant throughput) and that growth in uncontrolled emissions is equivalent to growth in plant activity as defined by the dimensionless growth factors. There is provision for user override of all growth factors, and user input of any local emission regulations (the program defaults to proposed Federal regulations).

- RUN DESCRIPTION

The processing routines are identical for industrial process, evaporation and miscellaneous point source emissions. All input and output data are passed through common storage; the subroutine argument list contains only two elements, a parameter to count the number of calls to the subroutine, and a switch to control printout of error messages. The data passed through common storage includes net emissions, control efficiency, allowable emissions, and compliance information for the base year from the NEDS file. Also passed are all necessary data on control regulations and projected growth.

There are two types of user-supplied control regulations affecting future point source emissions. One type affects only new equipment which becomes operational after the effective date of the regulation. These regulations are referred to in this section as new source standards. The other type of regulation is either in effect in the base year or will be in effect before the projection year, and governs both existing and new facilities. These regulations are referred to in this section as existing source standards.

The processing sequence of the subroutine is as follows. Net base year emissions are first converted to uncontrolled emissions using the base year control efficiencies. Growth factors and the effect of user supplied control regulations are applied to the uncontrolled emissions to produce one of the following types of output records:

- When no control standards are supplied: one record with emissions controlled by the base year control efficiency

- When only new source standards are given: one record with emissions which are affected by the base year control efficiency and one record with emissions which are affected by the new source standards

- When both existing and new source standards are given: one record with emissions which are affected by the existing standards and one record with emissions which are affected by the new source standards.

Thus one or two output records may be produced for each input record.

The next step in the processing sequence involves reducing the projected emissions if the projection year follows the expiration date of a variance and if projected emissions exceed the allowable emissions from which the variance was granted. Variance information and allowable emissions are included in the NEDS emission inventory data.

Projected emissions are finally returned through common storage to the main program.

10. SUBROUTINE NED253 (AREASC)

- **ABSTRACT**

The subroutine NED253 (AREASC) computes projected activity for all area sources other than transportation. Activity and not emissions is projected because the NEDS-USER file contains only activity data for area sources. Emissions are calculated by NEDS summary reporting programs (e.g., NE11) which accept NEDS-USER area source data as input. The subroutine is passed base year activity data from the main program NE253 (REPS) via the argument list, growth factors are applied to the base year activity, and projected activity is returned via the argument list (under the same data format) to the main program. Nontransportation area source activity includes fuel combustion, solid waste disposal and evaporation. There is provision for user override of the fuel mix, substitution of electricity for fossil fuels, and average energy consumption per capita in the projection year, as well as for growth factors for the activity categories. User override data are available to the subroutine through common storage.

- **RUN DESCRIPTION**

Each time the subroutine is called, all nontransportation area source activity data from one NEDS area source record is processed. The processing sequence is fuel use, solid waste and evaporation.

Base year Btu demand for each customer category (residential, commercial/institutional and industrial) is computed, modified if necessary by the expected change in substitution of electricity (user-supplied), projected to the future Btu demand, and reapportioned to future fuel use. (In the absence of user-supplied future fuel mix use the base year mix is used). Solid waste disposal and evaporation-producing activity are simply multiplied by the projected growth factors. Default growth factors used when others are not supplied by the user are:

- Residential fuels and solid waste disposal: population

- Commercial/institutional fuels and solid waste disposal: total industrial gross output

- Industrial fuels and solid waste disposal: total industrial gross output
- Evaporation: population.

Projected activity is returned to the main program through the argument list.

11. SUBROUTINE NEE253 (TRANS)

- ABSTRACT

The subroutine NEE253 (TRANS) computes projected activity for all transportation sources. Activity and not emissions is projected because the NEDS-USER file contains only activity data for all area sources. Emissions are calculated by NEDS summary reporting programs (e.g., NE11) which accept NEDS-USER area source data as input.

The subroutine is passed base year data on fuel use, activity and emissions for all transportation sources, and the necessary growth factors, from the main program NE253 (REPS). Any user-supplied projection data are also accepted and future transportation fuel use, activity and emissions (in the same format) are computed and returned to the main program. All data are passed to and returned from the subroutine through the argument list.

- RUN DESCRIPTION:

The input data passed to the subroutine from the main program NE253 (REPS) include the following transportation activity data from the NEDS-USER area source file:

- Light-duty vehicles: gasoline use
- Heavy-duty vehicles: gasoline and diesel use
- Vehicle miles traveled (VMT) combined for all vehicles
- Off-highway vehicles: gasoline and diesel use
- Rail locomotives: diesel use
- Vessels: anthracite coal, diesel, residual oil, and gasoline
- Aircraft: landing-takeoff cycles (LTO) for commercial, civilian and military aircraft.

Since the output of the main program NE253 (REPS) will be projection data to be converted by program NE052 to standard NEDS-USER file format, the output data returned to REPS must include, and are limited to, the above categories.

The user may input growth factors for any of the five transportation categories. The population growth factor is used as the default growth factor for all transportation sources in the absence of such overrides. Additional user input options are available for projections of highway vehicle activity for the three types of highway vehicles: light- and heavy-duty gasoline and heavy-duty diesel vehicles. These additional user inputs include growth factors for VMT and the projected percentage of future VMT for each vehicle type. Input data and growth factors are combined in the subroutine to produce projections of transportation activity, which are returned to the main program using the input data format.

One additional function is performed by the subroutine. The first time the subroutine is called by the main program NE253 (REPS), weighted emission factors for NOX, CO, HC (exhaust) and HC (evaporation) are computed for light- and heavy-duty gasoline vehicles. These are computed from published data on low mileage emission factors, deterioration of control devices due to vehicle age, average vehicle speed and weighted annual travel of vehicles of a given age. Some of these factors are a function of the projection year, so they cannot be computed until they first pass through the subroutine. The composite emission factor for HC is formed as the sum of the weighted factors for HC (exhaust) and HC (evaporation).

These emission factors are combined with projected activity for gasoline highway vehicles (fuel use and VMT) to compute projected emissions for these vehicles. These data are also returned to the main program and printed out immediately, since emissions cannot be included in projected NEDS records. Emissions are calculated in this manner because summary reporting programs (e.g., NE11) operating on the NEDS-USER file data compute highway vehicle emissions using emission factors appropriate for the current year, not a projection year.

12. PROGRAM NE052 (NEDS-OUT)

- ABSTRACT

The COBOL program NE052 (NEDS-OUT) is the final module in the REPS System. This program takes the FORTRAN-oriented records containing projected regional activity and emissions [the output of the NE253 (REPS) program] and creates 552 character, standard format NEDS-USER file records. The resulting output file contains both point and area source records. These records are identical with the base year NEDS records in data and format except for those parameters which were modified to reflect the growth in activity for the projection year. Summary reporting programs can be executed against this file to produce statistical reports for the projection year. An example would be a projection NER generated by the NE11 program. For more information on available reporting program consult the program documentation library of the EPA Aerometric and Emissions Reporting System (AEROS).

- RUN DESCRIPTION

The program contains three major elements, a COBOL main routine and two FORTRAN subroutines (NEA052, NEB052). One subroutine (NEB052) reads all the projected point source records and the other subroutine (NEA052) reads all the projected area source records. These subroutines pass the data to the COBOL main routine which writes the standard 552 character sequential record in NEDS-USER file format. Upon completion of this program the temporary files containing the projected point and area source inventory data (output of the NE253 program) can be deleted.

END

DATE

FILMED

5-3-76

NTIS