EPA-AA-TEB-81-11

Mobile Source Emission Inventory

by

Mark Wolcott

December 1980

Test and Evaluation Branch
Emission Control Technology Division
Office of Mobile Source Air Pollution Control
Office of Air, Noise, and Radiation
U. S. Environmental Protection Agency

Mobile Source Emission Inventory

Within the Office of Mobile Source Air Pollution Control (OMSAPC), a Program Assessment Group has been established to evaluate and direct mobile source control programs. This paper focuses on one input into that evaluation, the development of emission inventory estimates for a variety of mobile pollution sources. Both current (1977) and future (up to 2005) year inventories are estimated. Eighteen different types of mobile sources are considered to ascertain the contribution of unregulated as well as presently regulated sources. Virtually all counties in the United States and its territories are included for one portion of the analysis. The majority of the analyses include only those counties that have the potential to violate the National Ambient Air Quality Standard (NAAQS) for carbon monoxide (CO), ozone (O_3) or nitrogen oxides (NOx). This paper begins by projecting future baseline emissions and is founded on a set of assumptions consistent with past air quality analyses. From this baseline the sensitivity of those estimates to the underlying assumptions used is examined. Twelve sensitivity scenarios are considered. In each scenario one of the baseline assumptions is altered. Then, the result of the alteration is interpreted in terms of its likely air quality impact.

National Emission Data System

This paper is based on emission inventory estimates from the National Emission Data System (NEDS) maintained by the Office of Air Quality Planning and Standards (OAQPS) (Reference 1). NEDS contains emission estimates for five air pollutants: CO, hydrocarbons (HC), NOx, particulates and sulfur oxides (SOx). The NEDS inventories are available on a county by county basis. For each county an inventory is constructed from estimates of emission factors and activity levels for each pollution source cataloged by OAQPS. For example, light-duty vehicle emission factors are measured in grams of pollutant emitted per mile of travel and the activity level is measured as the annual number of miles traveled for all vehicles. The inventory, then, is the product of the appropriate emission factor and the activity level. For some categories, such as farm equipment, another step is required. The emission factors available for farm equipment are measured in grams of pollutant per hour of use. Estimates of the tractor population and the annual average number of hours a tractor is used are also recorded. The activity level is the product of the tractor population and this usage rate. As before, the inventory is the product of the activity level and the emission factor rate.

Based on the OAQPS nationwide inventory, in 1977 transportation sources accounted for approximately 85 percent of CO emissions, 46 percent of HC emissions, 43 percent of NOx emissions, 11 percent of particulate emissions and 3 percent of SOx emissions. Since mobile sources account for proportionately more CO, HC, and NOx than particulate and SOx emissions, this report is restricted to these three pollutants.

There are approximately 3,200 counties in the United States. Each year OAQPS estimates an emissions inventory for each of these counties. The latest available inventory is for the 1977 calendar year. For highway mobile sources that inventory is based primarily on March, 1978, emission factors and estimates of vehicle miles traveled. (The latter is derived from county fuel consumption.) For stationary sources the inventory is based on reports from state air pollution control agencies and other federal agencies. In NEDS estimates for five major sources of pollution are reported. Also included are estimates for many comparatively minor pollution sources.

The five major pollution sources are:

1. Fuel combustion
2. Industrial processes
3. Solid waste disposal
4. Transportation
5. Miscellaneous

The transportation category includes:

1. Light duty vehicles
2. Light duty trucks
3. Heavy duty gasoline trucks
4. Heavy duty diesel trucks
5. Gasoline off-highway vehicles
6. Diesel off-highway vehicles
7. Locomotives
8. Vessels
9. Aircraft

The NEDS light duty vehicle category includes motorcycles, automobiles, and light duty trucks less than 6,000 pounds gross vehicle weight. The heavy duty gasoline category includes all gasoline trucks greater than 6,000 pounds. The gasoline off-highway category includes farm and construction equipment as well as industrial equipment, lawn and garden equipment, snowmobiles, and off-highway motorcycles.

These NEDS categories were adapted to fit the requirements of this study: namely a more detailed look at both present and future mobile source emissions than is possible without such adaption (Reference 2). Motorcycles were separated from the light-duty vehicle group. Two light-duty truck categories were created: light-duty trucks less than 6,000 pounds and light-duty trucks between 6,000 and 8,500 pounds. These categories correspond to those used by the emission factor computer program, MOBILE1. The off-highway group was also split into its component parts: farm equipment, construction equipment, industrial machines, off-highway motorcycles, lawn and garden equipment, and snowmobiles. Organizing the mobile source categories to correspond with MOBILE1 categories results in more precise inventory estimates. Expanding the number of mobile source categories allows a more detailed study of those that contribute most to the total emissions burden.

Basically, to calculate the mobile source inventory under the NEDS procedure, county fuel consumption is estimated for each vehicle type. Second, the amount of this consumed fuel is multiplied by national average fuel efficiencies in miles per gallon (mpg) for each vehicle type. The results are county by county vehicle miles traveled (VMT) estimates. (For states in which measured VMT are available, estimated VMT calculated from fuel use data are adjusted to agree with the total county measured VMT reported by the State Highway or Transportation Department.) The estimated VMT's are then multiplied by MOBILE1 emission factor estimates to produce a highway mobile source emissions inventory.

For non-highway transportation sources the NEDS emissions inventory was used directly. Stationary source emission inventories were also obtained directly from NEDS. Together with the transportation sources, stationary sources account for all estimated emissions. The inventory thus constructed is consistent with the 1977 NEDS inventory recommended by OAQPS for air quality analyses and review of the NAAQS. It forms the basic current year inventory from which the future baseline inventories are calculated and to which the results from the sensitivity analysis are compared.

Relative Mobile Source Contribution, 1977 Inventory

Figures 1-3 show the relative contribution of mobile source emissions to total 1977 county emissions for each of the three pollutants considered in this report. The horizontal axis in these figures indicates the percent of total emissions contributed by mobile sources. (The percent of emissions contributed by stationary sources can be computed as 100 percent minus the percent of emissions contributed by mobile sources.) The vertical axis indicates the number of counties in the United Stated and its territories at each mobile source contribution level. As these figures indicate, mobile sources account for a relatively large share of emissions in many counties. In 5 percent of the counties, mobile sources contribute more than 98 percent of the CO, more than 84 percent of the HC, and more than 96 percent of the NOx. However, most of the 284 counties comprising this 5 percent are in remote areas containing few stationary emissions sources. The high mobile source contributions for these counties contrasts with an average contribution of 84 percent for CO, 56 percent for HC, and 72 percent for NOx.*

In Figure 1, the peak at 95 percent signifies that in 284 out of approximately 3200 counties, 95 percent of all CO county emissions are due to mobile sources. At the other end of the horizontal axis, however, there are a few counties in which mobile sources contribute a small percentage of total CO emissions. In most of these counties, the dominant sources

*Since stationary sources emit massive amounts of pollutants in relatively few counties, the average mobile source contribution within the nation's counties is different from the overall mobile source contribution. For example, in the average county mobile sources account for 75 percent of NOx emitted; for the nation, mobile sources contribute 43 percent of total NOx.

of emissions are forest wildfires and forest managed burning. This is particularly true in Alaska, Idaho, Montana, and Puerto Rico. However, there are a few counties in the Southwest in which chemical manufacturing is the dominant source of CO. These counties often contain carbon black manufacturing plants, which, when uncontrolled, emit large amounts of CO.

As Figure 2 indicates, the degree to which mobile sources account for total county emissions varies more for hydrocarbons than for carbon monoxide. While mobile sources contribute 84 percent or more of total hydrocarbon emissions in a few counties, they contribute substantially less in the majority of counties. In the counties with the lowest proportion of mobile source HC emissions there are three dominant types of sources. The first is a combination of forest wildfires and forest managed burning. The second is organic solvent evaporation, generally composed of painting and other types of wood preparation. Petroleum storage and transport comprise the third type of source found in these low mobile source contribution counties.

Figure 3 shows the relative contribution of mobile source NOx emissions to total county emissions. As with the other two pollutants, in a few counties mobile sources contribute a small percentage of total NOx emissions. A dominant source of emissions in those counties is electric power generated from bituminous coal. However, residual oil, natural gas, and lignite are also used.

In order to narrow the focus for further study, a joint set of counties in which there are definite air quality problems was selected from the nation's 3200 county total (Reference 2). First, a list of 146 counties showing violations of the eight hour average National Ambient Air Quality Standard (NAAQS) for CO (10 mg/m^3) was constructed. To this list were added 90 counties with at least one annual 1976-1978 mean NO_2 value greater than 60 mg/m^3. Although the current NO_2 NAAQS is greater than this, NO_2 emissions are anticipated to increase in the years ahead. Eventually, growth in CO and NMHC pollution sources will dominate the reduction in per unit emissions from cleaner technology. For NOx, however, the increase in total emissions is expected sooner than for CO and NMHC. Since counties now meeting the NO_2 standard may not meet it in the future, all counties with at least one annual mean within 60 percent of the NAAQS were included in the NO_2 list. (The CO and NO_2 lists have 62 counties in common.) Next, a list of Air Quality Control Regions (AQCR) with violations of the 0.12 ppm one-hour O_3 NAAQS in 1975-1977 was assembled. Generally, AQCR's are used to characterize NMHC inventories since transport and precursor reactivity generally occur in areas larger than counties. However, to be consistent with the other inventories used in this analysis, the NMHC inventory was constructed on a county basis. Further, since the focus of this paper is the inventory sensitivity to the assumptions underlying it, the distribution of emissions among pollution sources is more important than the absolute emission levels. Since in eight AQCR's sampled the mix of sources is roughly the same for the AQCR as its most urban county, it was assumed that the mix of sources would also be approximately the same in the most urban county as in the whole AQCR. Therefore, in order to keep the joint list of counties at a manageable size, not all of the counties in each O_3 AQCR were included. Instead, a different selection procedure was used.

Since the 69 AQCR's that registered violations of the O_3 NAAQS contain approximately 500 counties, if an AQCR was represented by at least one county on the combined CO and NO_2 list, than no other counties from that AQCR were added to that list. For an AQCR not represented, one county within it (usually the one with the largest population) was chosen. The aim of this selection criterion was to minimize the total number of counties on the joint list, yet still represent each violation area. With the exception of the distributional analysis described in the next three paragraphs, it is this joint list of counties that is considered throughout the remainder of the paper. (For the distributional analyses, the three individual lists from which the joint set was constructed are used.) Appendix A contains the state, county and AQCR codes for each of the included counties. All except the four Connecticut counties were subsequently used. (NEDS data for Connecticut were erroneous at the time the analysis was conducted.) Figures 4-6 show the relative contribution of mobile source emissions to total county emissions for these counties. The general shape of Figure 4 (146 CO counties) follows that of Figure 1 (all 3200 counties). However, in Figure 1 there are several counties represented in which mobile sources contributed a negligible portion of total CO. Among the 146 counties representing areas with ambient CO violations, mobile sources contributed at least 37 percent of total CO emissions in each county.

The distribution of mobile source HC emissions for the 142 worst O_3 counties is presented in Figure 5. As in the case of CO, the general shape of Figure 5 follows that of Figure 2. However, as demonstrated by Figures 3 and 6, the distribution of mobile source NOx emissions for the two groups of counties is different. The peak at 90 percent in Figure 3 is absent from Figure 6 indicating that the mobile source contribution among the 90 counties with the greatest potential to violate the NO_2 NAAQS varies much more than the mobile source NOx contribution for the nation as a whole.

Another way to distinguish the differences between the set of all counties and those counties with the potential to violate the NAAQS is to calculate and compare the percentiles associated with each distribution. These percentiles indicate the range of the mobile source contributions to the county emissions. The 50th percentile is equivalent to the median. For CO the median mobile source contribution for the nation's 3200 counties is 92 percent. That is, mobile sources contribute more than 92 percent of total CO emissions in one-half of all counties. Further, mobile sources contribute more than 40 percent of CO emissions in 95 percent of all counties (5th percentile). Finally, at the other extreme, mobile sources contribute more than 98 percent of total emissions in 5 percent of all counties (95th percentile). In other words, in 90 percent of all counties, mobile sources contribute between 40 percent and 98 percent of CO emissions. These data are listed in Table 1. Table 1 also lists, for all 3200 counties, the 5th, 50th and 95th percentiles of the mobile source contribution for HC and NOx. In addition, both the mean and the maximum contribution are included. The 100 percent maximum contribution indicates that all CO, HC, or NOx emissions are accounted for by mobile sources in at least one county.

Table 2 lists these same statistics for the disjoint set of counties representing the areas with the potential to violate the NAAQS. For these selected counties mobile sources generally account for a greater proportion of CO emissions and a lesser proportion of HC and NOx emissions than in the country as a whole. However, in seven counties (five percent) mobile sources account for a small proportion of CO emissions. Two of these counties contain primary metal processing plants, one contains a chemical manufacturing plant and one contains a solid waste disposal plant. Most of the low mobile source HC counties are dominated by large amounts of solvent evaporation loss. Electric power generating facilities dominate those counties in which mobile sources contribute a small proportion of total NOx emissions (Reference 3).

Up until this point the discussion has centered on the 1977 base year inventory. In order to develop a sound policy of emission control, it is necessary to know what the future emission inventory is expected to be. In order to project future year emissions, several assumptions must be made. The compound annual increase in the activity level of each individual source must be estimated for both mobile and stationary sources. The promulgation of new regulations and the rate at which the regulated newer technology replaces existing technology must also be taken into account, as must the deterioration of that existing technology. The following section of this paper examines the sensitivity of the future emissions estimates to the underlying assumptions used to create them. One set of assumptions is used as a baseline with which twelve other cases are compared.

The future year inventory material is arranged in four parts. The first part discusses the baseline assumptions. The second part discusses each sensitivity scenario and how the scenario results differ from the baseline. Only CO is considered in part two. Parts three and four include a similar discussion of the results obtained for NMHC and NOx.

Baseline Inventory

For the baseline, mobile sources are expected to grow at a one percent compound annual rate for all categories except HDG and HDD (Reference 4). HDG VMT is assumed to decline at an annual rate of two percent; HDD VMT is assumed to increase at an annual rate of five percent (Reference 5). These rates are consistent with those used in support of recent air quality analyses. For highway vehicles these VMT growth rates are multiplied by the future year MOBILE1 emission factor estimates to arrive at the estimated baseline inventory (Reference 6). For non-highway mobile sources, such as railroads, aircraft and vessels, NEDS 1977 base year emissions estimates are assumed to grow at a one percent compound annual rate.

For the baseline, the stationary source expected growth rates that were used are also consistent with recent air quality analyses. Table 3 lists these stationary growth rates for CO (Reference 4). NMHC and NOx stationary source growth rates are listed in Tables 4 and 5, respectively (References 7 and 8).

For both mobile and stationary sources, the level of future year emissions is a function of new regulations, an assumed source deterioration rate, and the rate at which old technology is retired and replaced by new, presumably cleaner, technology. For mobile sources all these factors are incorporated into the future year emission estimates predicted by MOBILE1. All of the future light duty vehicle emission factor estimates used in this analysis assume an inspection maintenance program beginning in 1982. A 30 percent stringency factor is used but no mechanic training is assumed. To project future emissions from stationary sources, these factors are applied separately to the uncontrolled emission estimates.

No assumption is made about stationary source deterioration rates; that is, no deterioration rate is applied. Instead, old stationary sources are assumed to retire and be replaced by new sources. These new sources remain controlled to the levels originally mandated by new source performance standards (NSPS). Old sources that have not yet been retired in areas that are expected to exceed the NAAQS in 1982 are presumed to be controlled for the remainder of their operation to reasonably available control technology (RACT) levels. The NSPS and RACT levels are presented for each pollutant in Tables 3-5.

The following example illustrates how RACT and NSPS controls are applied. Assume commercial coal facilities in an area that is not expected to meet the NO_2 NAAQS are to grow at a 1.0 percent compound annual rate (Table 5). Growth includes both expanded capacity of existing facilities and construction of new facilities. Emissions from this increased capacity are expected to be 24 percent less than pre-control levels. In addition, existing coal facilities are assumed to be retired at a 4.0 percent compound annual rate and be replaced by new capacity. The emissions from the new capacity are also expected to be reduced by 24 percent. Emissions from the remaining facilities are expected to be reduced by 20 percent.

There are potential problems with some of the NSPS and RACT assumptions represented in Tables 3-5. For example, new petroleum refineries are controlled to a lesser degree than existing refineries with RACT (Table 4). However, the degree of NSPS and RACT control assumed for the baseline case in this paper is consistent with that used in air quality analyses and recommended by OAQPS.

In order to examine the sensitivity of the baseline inventory estimates to a variation in each input assumption, twelve different scenarios were constructed. One scenario is used to examine the effect of low ambient temperatures. Two scenarios relate to the effect of changing the highway mobile source and stationary source retirement rates. In four scenarios the effects of changing the driving cycle over which mileage is accumulated are considered. Four scenarios are used to project emissions under different mobile and stationary source expected growth rate assumptions. Finally, the effect of changing the degree of stationary source NMHC control is examined.

Three types of information are presented for each scenario examined. These are: an inventory for each emissions source; the percentage contribution of each source relative to the total mobile or stationary source portion of the inventory; and the relative contribution of each source with respect to the total inventory. This information is presented for the baseline in Tables 6, 7 and 8. Only the counties with the greatest potential to exceed the CO, O_3 and NO_2 NAAQS are included.

Table 6 presents the CO emissions inventory for each mobile and stationary source. Eighteen mobile sources are used in this analysis. Those are listed in Table 9 along with the abbreviations as they appear in subsequent tables. Light duty diesel vehicles and trucks will be included once they have been incorporated into MOBILE1. The stationary sources used are listed in Table 10.

As indicated in Table 6 for the baseline case, total CO emissions are expected to decline from 49,800 thousand tons in 1977 to 18,150 thousand tons in 2005. During this period the proportion of mobile source CO emissions from light duty gas vehicles is projected to decline from 64 percent to 41 percent (Table 7). The proportion of total county CO emissions contributed by all mobile sources is expected to be decline from 90 percent to 81 percent (Table 8). This overall reduction is largely the result of cleaner light duty vehicles.

To further illustrate the relative contributions of the various emissions sources and how these contributions change over time, Figures 7 and 8 have been constructed to graphically present the data. Figure 7 shows the contribution of both mobile and stationary sources for the base year and each projection year thereafter. The numbers in this figure are identical to those in Table 6 under the headings MOBILE TOTAL and STAT TOTAL. Figure 8 shows the relative contribution of each mobile source category to total mobile emissions. The numbers in this figure are identical to those in Table 7.

Immediately apparent from Figure 7 is the relatively large proportion of CO emissicns attributed to mobile sources. Also apparent is the significant decline in total future year emissions. Clearly, most of this decline is the result of the decline in mobile source emissions. Perhaps more importantly, by 2005 under this scenario, expected growth in both mobile and stationary sources overcomes the emission reductions that, in prior years, have resulted from increased control.

Figure 8 shows the relative contribution of each mobile source category to total mobile source CO emissions. The OTHER category includes highway motorcycles as well as all off-highway categories except aircraft, vessels and locomotives. The increase in the relative contribution of off-highway vehicles is primarily the result of the reduction in the light duty vehicle contribution. Nevertheless, by 2005 CO from gas farm and construction equipment and from gas industrial machinery, taken together, are projected to match CO emissions from light or heavy duty gas trucks and to exceed emissions from railroads, vessels and aircraft.

Sensitivity Analysis

Since the estimation of future year inventories is tied so closely to the underlying assumptions, twelve different scenarios were constructed to examine the sensitivity of the baseline inventory estimates to those assumptions. For each scenario, only one baseline assumption was changed.

The first step in the sensitivity analysis relates to ambient temperature. A 68°-86°F ambient temperature is assumed for the standard light--duty Federal Test Procedure (FTP) (Reference 6). According to OAQPS, the average national summertime temperature is 76°F (Reference 1). NEDS county emissions are estimated by adjusting the standard FTP mobile source emissions to reflect the average summertime temperature of the state to which the county belongs. This same adjustment was made for the baseline inventory discussed previously. For the low temperature scenario, however, highway mobile source emissions were adjusted to reflect the average wintertime temperature. On a national scale this works out to be 40°F. The purpose of examining this scenario is to estimate an emissions inventory under conditions that approximate winter month temperature conditions in which CO emissions tend to be greater. For this scenario in the counties most likely to exceed the NAAQS, total 1977 CO emissions increase six percent, from 49,800 thousand tons to 52,950 thousand tons, over what they are projected to be under conditions that approximate summertime temperatures. (Since annual VMT was used to calculate this inventory and not just wintertime VMT, the absolute tonnage numbers should not be used by themselves but can be compared relative to the inventories obtained from modifying other baseline assumptions.) The changes in CO levels for this and other scenarios are summarized in Table 11. Table 12 summarizes the changes in the mobile source contribution to total CO emissions for each of the scenarios. The table indicates that for 1977 decreasing the temperature an average of 47 percent increases by two percent the mobile source contribution to total county emissions (from 89.6 percent for the baseline case to 91.1 percent in the low temperature case).

The effect on the inventory of changing the type of driving assumed to generate the mobile source portion of the inventory is examined in the second step of the sensitivity analysis. The Federal Highway Administration (FHwA) estimates VMT on urban and rural roads. To calculate the emissions inventory from highway vehicles, OAQPS assumes that the average urban speed is 19.6 mph and that 43 percent of vehicle trips are cold starts; 57 percent of trips are assumed to be hot starts (Reference 1). Rural VMT, on the other hand, is assumed to be accumulated at a rate of 45 mph, with all vehicles operating in the hot stabilized condition. For the baseline case the county inventory is the sum of the weighted urban and rural portions calculated in the usual fashion; i.e., the urban emission factor times the urban VMT plus the rural emission factor times the rural VMT.

In order to test the sensitivity of mobile source emissions to the type of driving cycle over which vehicle mileage is accumulated, two other driving cycle scenarios were considered. In the first of these two scenarios, designated RURAL in the tables and graphs, all mileage was assumed to be accumulated under high speed, warmed up operation. In the second scenario, designated URBAN, all mileage was assumed to be accumulated under FTP speed and vehicle operating conditions. For the baseline case the speed and operating conditions were set at the levels described in the previous paragraph.

As expected and as Table 11 indicates, there is a substantial (48 percent) decrease in CO emissions for rural driving conditions. Conversely, there is a substantial (10 percent) increase in emissions for urban driving conditions. However, since in most of the counties examined in this report the majority of the baseline mileage is accumulated under urban driving conditions, the effect of changing the type of driving to all rural is to reduce CO emissions more than they are increased by changing to all urban driving. This is due to the urban/-rural weighting applied to construct the baseline inventory. In most counties with an air quality problem 80 percent of highway mobile source emissions is generated along urban roads. Only 20 percent is generated along rural roads. Although the air quality effects of changing the baseline assumptions are not estimated, the inference to be drawn from these two scenarios is that, for CO, which tends to be an urban problem, the emissions inventory estimates used in past air quality analyses may be low. However, this is not a serious air quality concern. For air quality projections the relative inventory change is important, not so much the level from which that change occurs. A problem potentially greater than underestimating the emissions inventory arises if a cycle other than the FTP better represents driving conditions in areas characterized by high ambient CO concentrations. New York City is an example of such a situation. If New York driving is better represented by a low average speed cycle with many stops and starts (such as the New York City cycle) than by the FTP, then the inventory for New York City has been greatly underestimated both in NEDS and in past air quality analyses. Further, estimates of emission reductions resulting from the introduction of cleaner vehicles that have been made in the past will only be achieved if the emissions from those vehicles are reduced in the same or greater proportion under the New York City cycle as they are reduced under the FTP.

Four of the twelve scenarios test the sensitivity of the mobile source contribution to changes in the annual expected growth of both mobile and stationary sources. Baseline expected growth rates are consistent with recent air quality analyses. Generally, for mobile sources the baseline VMT growth rates are one percent compounded annually. The two exceptions to this rule are that heavy duty gas truck VMT is assumed to decrease at an annual rate of two percent while the heavy duty diesel VMT is assumed to grow at an annual five percent rate. For the sensitivity analysis, mobile source growth rates are first reduced by one percentage point from these levels and next increased by two percentage points. For each of these cases, stationary source expected growth rates remain unchanged from the baseline.

The low mobile source growth rate scenario is probably unrealistic. It has been included to put a lower bound on the estimates of mobile source emissions. Since most of the baseline mobile source growth rates are one percent, the low mobile source growth rate assumption is approximately equivalent to assuming no mobile source growth. The high mobile source growth rate, on the other hand, assumes that mobile sources grow at approximately a three percent annual rate. This is the upper bound of the range OAQPS recommends be used in air quality analyses.

As Table 11 indicates, under the low mobile source growth rate scenario, total CO emissions in 2005 decline 71 percent from 1977 levels. Under the high mobile source growth rate scenario, total emissions in 2005 decline only 42 percent. For the baseline VMT growth rates, CO emissions decline 64 percent over this same 28 year span. Perhaps more importantly, as Table 12 shows, under the low mobile source growth rate scenario, the proportion of total CO emissions accounted for by mobile sources declines 14 percentage points from 90 percent in 1977 to 76 percent in 2005. This decline is only 2 percentage points for the high mobile source growth rate scenario. The proportion of total emissions accounted for by mobile sources declines 9 percentage points over this same period for the standard baseline growth rate assumptions.

The effect of the stationary source expected growth rates on the inventory are examined next. The mobile source expected growth rates are held constant at the baseline level. Stationary source growth rates are first decreased by two percentage points and then increased by two percentage points. This wide range has been choosen to put lower and upper bounds on the growth rates applied to the stationary sources listed in Tables 3-5. It is unlikely that stationary sources would achieve growth rates at these extremes for the next three decades. Their inclusion, however, provides a useful insight into the sensitivity of emissions to stationary source growth.

Under the low stationary source growth rate scenario, total CO emissions decline 67 percent from 1977 to 2005. Under the high stationary growth rate scenario, total emissions decline 58 percent for the same period. This 9 percentage point difference is considerably less than the 39 point difference under the high and low mobile source growth rate scenarios and is due to the large proportion of CO emissions contributed by mobile sources. As seen later in the paper, the effects of mobile and stationary source growth rates are more equivalent for NMHC and NOx.

Two sensitivity scenarios have been included to reflect the increase in emissions that are likely to result from acceleration/deceleration rates greater than those specified by the FTP (Reference 9). The mechanism used is to increase the baseline light duty vehicle emission factors by 50 percent (designated +50 LDV in the tables and graphs) and 100 percent (designated +100 LDV). The baseline factors were taken from the March, 1978 Mobile Source Emission Factor document. Increases of 50 and 100 percent from those factors are used.

Under the +50 LDV emission factor scenario, the 1977 CO inventory increases 29 percent over the baseline level. Under the +100 LDV emission factor scenario, the 1977 inventory increases 57 percent. For these two scenarios emissions in 2005 also increase substantially. However, the ratio of 2005 to 1977 CO emissions is not much different from the corresponding baseline ratio. Under the +50 scenario CO emissions decline 67 percent from 1977 to 2005. Under the +100 emission factor scenario, the decline is 69 percent. The baseline decline is 64 percent.

Tables 11 and 12 summarize the results associated with all the scenarios studied in the sensitivity analysis. Table 11 can be used to determine the extent to which the predicted change in emissions from 1977 to 2005 varies from the baseline among the different scenarios. If there is no variation in the predicted emission change, then under the currently utilized ROLLBACK procedure there would be no expected variation in air quality. However, to the extent that there is a difference in predicted inventory levels, there will be a corresponding difference in predicted air quality.

Among the sensitivity scenarios considered, three show no difference from the baseline level in the CO inventory change from 1977 to 2005. Two of those are the low and high stationary source retirement scenarios. The scenario that assumes that all mileage is accumulated under urban driving conditions also shows no difference in the 1977 to 2005 percent reduction achieved from the baseline.

Five scenarios show a greater reduction in total CO emissions from 1977 to 2005 than the baseline case shows. These scenarios are the low temperature, low mobile source growth, low stationary source growth, and +50% and +100% LDV emission factor scenarios. The greatest difference is shown in the low mobile source growth scenario which shows a 70 percent reduction in CO emissions from 1977 to 2005. This contrasts with the 64 percent baseline reduction. If one believes that the low mobile source growth (essentially no growth) scenario is realistic, then past air quality analyses have underpredicted the expected improvement in air quality.

In three of the sensitivity scenarios a reduction in total CO emissions from 1977 to 2005 smaller than is shown in the baseline case occurs. These are the rural driving, high mobile source growth and high stationary source growth scenarios. The least reduction is 42 percent shown by the high mobile source growth scenario. If this (essentially three percent growth) scenario is realistic, than past air quality analyses have overpredicted the improvement in air quality by approximately 21 percentage points (34 percent).

A second air quality interpretation can be made from Table 12 relating to the proportion of CO emissions generated by mobile sources among the different scenarios. If a smaller proportion of emissions is generated by mobile sources under the various scenarios than is predicted for the baseline case, then increase mobile source control would be needed under the scenario conditions to obtain air quality improvements equal to those obtained for the baseline.

For five scenarios the mobile source proportion of total emissions is significantly different from the baseline proportion. Assuming that all highway mobile source mileage is accumulated under rural driving conditions results in an 11 percent drop in this proportion (from 90 percent for the baseline to 80 percent in the RURAL case). On the other hand, the low temperature, URBAN, +50 LDV and +100 LDV scenarios result in slight increases in the mobile source proportion of total CO emissions. By 2005 the mobile source proportion of total CO emissions declines somewhat under all scenarios, including the baseline. As one would expect, the decline is least (two percent) under the high mobile and low stationary source growth scenarios.

NMHC

Up until now the discussion has been focused on the CO inventory. The same scenario conditions as described for CO were used to calculate the sensitivity of the NMHC and NOx inventories to the baseline assumptions. Figure 9 shows how NMHC emissions are projected to change under the baseline conditions. As in the case of CO, total NMHC is expected to decline through 1995. After 1995, growth in the activity levels of NMHC pollution sources overtakes the reduction in source emissions that result from cleaner technologies. Figure 10 shows the corresponding proportion of mobile source emissions allocated to each category. The dominant trends shown are the reduction in the proportion of light duty vehicle and heavy duty gas truck emissions and the increase in the heavy duty diesel truck emissions. Heavy duty diesel emissions are projected to match the combined emissions from light and heavy duty gas trucks by 2005. Aircraft NMHC emissions are projected to exceed those from heavy duty gas trucks by the same year. (No aircraft emission control was assumed in this projection.) Railroad and vessel emissions are also projected to be significant. In contrast to CO, however, NMHC emissions from gas farm and construction equipment and from gas industrial machinery are expected to comprise, in 2005, a small proportion of total county emissions. Tables 15-17 present in more detail the same information shown in Figures 9 and 10.

Tables 18 and 19 summarize the NMHC scenario results. As in the case of CO, five scenarios show a NMHC inventory change from the 1977 baseline level. Under the low temperature scenario emissions are increased approximately two percent. For the all mileage accumulated under urban driving conditions scenario, the inventory is increased by four percent. Under all rural driving conditions the inventory is reduced by 18 percent. For the scenarios in which highway mobile source emission factors were increased by 50 and 100 percent, the 1977 emission inventory increases 10 and 21 percent, respectively.

For most sensitivity scenarios, the reduction in NMHC emissions from 1977 to 2005 is approximately 55 percent. This means that, in terms of ozone air quality, little difference is seen among the different NMHC scenarios. However, for the low stationary source growth scenario, NMHC emissions in 2005 are reduced 66 percent from 1977 levels. In contrast, under the high mobile and high stationary source growth scenarios, emissions are reduced only 45 and 38 percent, respectively. Making the simplistic assumption that changes in emissions are directly proportional to changes in air quality, past air quality analyses have overpredicted the improvement in ozone air quality by up to 17 percentage points (31 percent), if either of these scenarios is realistic.

Another aspect of the sensitivity analysis not yet discussed deals with the rate at which present stationary sources of emissions are retired or scrapped. These sources are assumed to be replaced by new, presumably cleaner, factories, equipment, etc. Three levels of control are assumed to apply to each type of stationary source. Old sources in areas that meet the NAAQS have associated with them one level of control.

Areas that are not expected to meet the NAAQS by 1983 must, at that time, have controls on old sources designated as reasonably available control technology (RACT). New sources must be controlled to levels specified by new source performance standards (NSPS).

For the sensitivity analysis changes in the retirement rate assumption are used to indirectly examine the effect of changing the average level of control applied to stationary sources. (Since a fixed retirement rate is assumed for CO stationary sources, this scenario was not discussed in the previous section.) In the low retirement scenario (designated as LO RETIR in the tables and graphs), the rate was reduced one percentage point from the levels indicated in Tables 3-5 (the baseline expected growth and control assumption tables). The effect of reducing the retirement rate is to decrease the average level of stationary source control, since old sources are scrapped at a lower annual rate. In the high retirement rate scenario (designated as HI RETIR), the rate was increased by one percentage point. The effect of this change is to increase the average level of stationary source control. The plus and minus one percentage point range was arbitrarily chosen. However, as Table 18 shows, changing the retirement rate has little affect on projected emissions.

The purpose of including the low stationary source control scenario in this study is to directly test the sensitivity of emissions to the NSPS and RACT NMHC assumptions. Neither CO nor NOx were considered for this scenario, although it would be possible to do so. Only NMHC was chosen for examination since the degree of stationary source control assumed in the baseline case is so great. For NMHC scenarios both the NSPS and RACT controls from Table 4 were reduced 50 percent. The assumed NSPS control on petroleum storage, for example, was reduced from 80 percent to 40 percent. Although the choice of 50 percent reduction is completely arbitrary, if stationary sources are controlled to a lesser degree than is generally assumed, future air quality will suffer. If this scenario is realistic, then the improvement in air quality has been overestimated by 31 percentage points (56 percent).

Table 19 shows the mobile source proportion of total NMHC emission for each scenario. Under the all rural driving scenario mobile sources account for a smaller proportion of total emissions. On the other hand, under the low temperature and urban driving scenarios mobile sources account for a slightly greater proportion of NMHC emissions than for the baseline. Also, both of the scenarios in which light duty vehicle emission factors are increased show mobile sources accounting for a larger proportion of NMHC emissions.

NOx

As Tables 18 and 19 indicate, the trends evident for CO emissions are also generally evident for NMHC emissions. NOx, however, is somewhat different. For CO and NMHC base year off-highway sources account for a small proportion of total county emissions. For NOx, however, railroads, vessels, aircraft, and diesel industrial machinery and construction equipment comprise 20 percent of mobile source county emissions. Also, as Figure 11 shows the projected changes in mobile and stationary NOx emissions through 2005 are different from the CO and NMHC projected changes. One difference between NOx and the other two pollutants is that total emissions begin to increase between 1987 and 1995. By 2005 NOx emissions are projected to be greater tnan they were in 1977.

Figure 12 shows the distribution of mobile source NOx emissions for each projection year. The slight increase between 1987 and 1995 in the projection of mobile source emissions accounted for by light duty vehicles is an artifact of the data. As Table 20 shows, total mobile source emissions decline through 1995. Light duty vehicle NOx emissions, however, decline only through 1987. Since, by 1995, light duty vehicle NOx emissions are increasing at the same time that total mobile emissions are declining, the proportion of mobile emissions accounted for by light duty vehicles increases. By 2005, however, both total mobile and the light duty proportion of mobile emissions are increasing. The net effect is that the proportion of mobile emissions accounted for by light duty vehicles starts a second downward trend by 2005.

By 2005 NOx emissions from diesel construction equipment and industrial machinery, taken together, are projected to exceed the combined light and heavy duty gas truck emissions. The same holds true for railroad NOx emissions by 2005. Tables 21 and 22 present in greater detail the information shown in Figures 11 and 12.

The trend differences between NOx and CO and NMHC become more evident in Tables 23 and 24. Table 23 summarizes the NOx inventory projections for each sensitivity scenario. Unlike CO and NMHC, NOx emissions are unaffected by low temperature, since MOBILE1 assumes that NOx emission factors are constant for all temperatures. Also different is the relationship between emissions and the assumed driving cycle. NOx emissions increase under the warmed-up, high speed rural driving cycle and decline for the cold start, slower driving assumed for the urban cycle. For CO and NMHC emissions the trend is just the opposite.

In most NOx scenarios the emissions inventory in 2005 is higher than the 1977 inventory. The inventory is as much as 42 percent higher for high mobile source growth. Only for low stationary source growth are NOx emissions in 2005 less than 1977 emissions.

Table 24 summarizes the contribution of mobile sources to total NOx emissions for each scenario. The table indicates two NOx trends that are different from CO and NMHC trends. Under the rural driving scenario the mobile source portion of total county emissions increases; under the urban scenario that proportion decreases.

Conclusions

The major conclusions drawn from this analysis are summarized below:

1. In the majority of counties with air quality problems, mobile sources account for 95 percent of the CO, 51 percent of the HC and 58 percent of the NOx.

2. Total CO and NMHC emissions are projected to decline through 1995 and to increase thereafter. Total NOx emissions are projected to decline through 1987 and to increase thereafter.

3. By 2005 CO emissions from gas farm and construction equipment and from gas industrial machinery, taken together, will match CO emissions from light or heavy duty gas trucks and exceed emissions from railroads, vessels and aircraft. On the other hand, NMHC and NOx emissions from these sources will be negligible.

4. Heavy duty diesel NMHC emissions will nearly match the combined emissions from light and heavy duty gas trucks by 2005. Railroad and vessel emissions will also be significant by that year. Aircraft NMHC emissions will exceed heavy duty gas truck emissions by 2005.

5. By 2005, NOx emissions from diesel construction equipment and industrial machinery, taken together, will exceed the combined light and heavy duty gas truck emissions. Railroad NOx emissions will also be significant by that year.

6. For all three pollutants the baseline 1977 emission estimates are sensitive to the assumed driving cycle. Projected inventory changes between 1977 and 2005, however, are also sensitive to the assumed mobile and stationary source growth rates.

7. The average mobile source contribution to total county emissions is also sensitive to the assumed activity growth rates. For high mobile source growth, the mobile source contribution will be nearly the same in 2005 as it is in 1977. The average mobile source contribution to total emissions will be 88 percent for CO, 45 percent for NMHC, and 53 percent for NOx.

Clearly, mobile sources will account for a large proportion of county emissions. As this paper has pointed out, the recent downward trend in total emissions is expected to be reversed. If the quality of air in our cities is to be improved, emissions from both mobile and stationary sources will have to be controlled to a degree greater than is presently projected.

List of Tables

Table 1
Percent of County-Wide Emissions Contributed by Mobile Sources
All Counties

Pollutant	Mean Percent Contribution(a)	Percentiles .05(b)	.50	.95	Maximum Percent Contribution(c)
CO	84.0	40.3(d)	91.9	98.4	100.0
HC	56.4	21.6	57.9	84.0	100.0
NOx	72.1	12.0	84.1	96.1	100.0

(a) Average mobile source contribution in percent
(b) Percentile of counties
(c) Maximum mobile source contribution for one county in percent
(d) Mobile source CO contribution, listed in percent, exceeded in 95 percent of all counties

Table 2
Percent of County-Wide Emissions Contributed by Mobile Sources
Counties with the Potential to Violate the NAAQS

Pollutant	Mean Percent Contribution(a)	Percentiles .05(b)	.50	.95	Maximum Percent Contribution(c)
CO	89.2	56.9(d)	94.6	98.7	99.7
HC	50.1	21.9	50.8	72.7	80.7
NOx	58.2	16.0	58.4	88.5	93.3

(a) Average mobile source contribution in percent
(b) Percentile of counties
(c) Maximum mobile source contribution for one county in percent
(d) Mobile source contribution, listed in percent, exceeded in 95 percent of all counties

Table 3

Baseline Assumptions for CO Stationary Sources

Stationary Source Category	Expected Compound Annual Growth Rate (Percent)	Degree of Control* (Percent)	Inventory Projection Year
	2.5	24	1983
Point	2.5	34	1987
Sources	2.5	50	1995
	2.5	62	2005
	1.0	24	1983
Area	1.0	34	1987
Sources	1.0	50	1995
	1.0	62	2005

* The NSPS, RACT, and the retirement rate are together reflected by this series. That is why both point and area sources show increased control over the years. Newer, cleaner sources, are replacing existing sources.

Table 4
Baseline Assumptions for NMHC Stationary Sources

Stationary Annual Source Category	Compound Annual Growth Rate (Percent)	NSPS Degree of Control (Percent)	RACT Degree of Control (Percent)	Compound Retirement Rate (Percent)
Combustion	0	0	0	2.0
Petroleum Refineries	2.0	85	90	4.0
Petroleum Storage	2.0	80	80	4.0
Industrial Processes	3.5	45	35	2.5
Solvent Evaporation	2.0	80	40	3.0

Table 5
Baseline Assumptions for NOx Stationary Sources

Stationary Source Category	Compound Annual Growth Rate (Percent)	NSPS Degree of Control (Percent)	RACT Degree of Control (Percent)	Compound Annual Retirement Rate (Percent)
Point Sources	2.5	30	25	0
Residential Oil and Gas	1.0	50	0	0
Commercial Coal	1.0	24	20	0
Commercial Oil and Gas	1.0	50	40	0
Institutional Coal	1.0	24	20	0
Institutional Oil and Gas	1.0	50	40	0
Other Area Sources	1.0	0	0	0

TABLE 6

CO : INVENTORY LEVELS SCENARIO : BASELINE

EMISSIONS (1000 TONS/YEAR)

MOBILE SOURCE CATEGORIES

	LDV-G	LDT1-G	LDT2-G	HDG	CYCLES	LDV-D	LDT1-D	LDT2-D	HDD	RAILROAD	VESSELS
BASE YR											
1977	28533.1	3449.7	2186.1	7414.5	270.8	0.0	0.0	0.0	740.3	114.2	176.3
PROJ YR											
1983	14235.5	2562.8	1879.9	5976.9	149.6	0.0	0.0	0.0	892.3	118.3	185.4
1987	7564.9	1677.1	1424.4	3694.7	56.1	0.0	0.0	0.0	1061.4	125.1	194.4
1995	5460.7	1073.1	862.7	2113.3	32.0	0.0	0.0	0.0	1531.3	135.7	210.1
2005	6031.7	1184.3	663.8	1558.5	36.6	0.0	0.0	0.0	2495.8	151.1	232.7

	AIRCRAFT		OH-MCYC	FARM-G	LAWN	SNOW	INDMCH-G	CONST-G	FARM-D	INDMCH-D	CONST-D	MOBILE TOTAL
BASE YR												
1977	399.5	0.0	29.2	260.7	0.0	12.1	692.0	251.3	9.2	14.8	50.1	44604.2
PROJ YR												
1983	422.8	0.0	29.4	275.9	0.0	12.2	733.8	265.2	9.3	14.9	51.1	27830.8
1987	441.3	0.0	30.4	287.3	0.0	13.0	764.3	277.3	9.4	15.0	53.6	17699.2
1995	478.1	0.0	33.2	312.9	0.0	13.9	827.2	300.9	10.0	15.3	59.0	13477.6
2005	528.1	0.0	37.4	344.3	0.0	15.5	914.7	333.1	11.0	17.7	66.0	14625.4

STATIONARY SOURCE CATEGORIES

	POINT	AREA								STAT TOTAL	GRAND TOTAL
BASE YR											
1977	3568.0	1628.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5196.3	49800.5
PROJ YR											
1983	3145.4	1314.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4458.7	32289.4
1987	3015.2	1187.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4201.1	21900.2
1995	2782.4	974.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3756.4	17233.9
2005	2707.4	819.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3524.5	18149.9

TABLE 7

CO : RELATIVE CONTRIBUTIONS SCENARIO : BASELINE

PERCENT OF MOBILE/STATIONARY SOURCE CONTRIBUTION

MOBILE SOURCE CATEGORIES

	LDV-G	LDT1-G	LDT2-G	HDG	CYCLES	LDV-D	LDT1-D	LDT2-D	HDD	RAILROAD	VESSELS
BASE YR											
1977	64.0	7.7	4.9	16.6	0.6	0.0	0.0	0.0	1.7	0.3	0.4
PROJ YR											
1983	51.2	9.2	6.8	21.5	0.5	0.0	0.0	0.0	3.2	0.4	0.7
1987	42.7	9.5	8.0	20.9	0.3	0.0	0.0	0.0	6.0	0.7	1.1
1995	40.5	8.0	6.4	15.7	0.2	0.0	0.0	0.0	11.4	1.0	1.6
2005	41.2	8.1	4.5	10.7	0.3	0.0	0.0	0.0	17.1	1.0	1.6

	AIRCRAFT		OH-MCYC	FARM-G	LAWN	SNOW	INDMCH-G	CONST-G	FARM-D	INDMCH-D	CONST-D	MOBILE TOTAL
BASE YR												
1977	0.9	0.0	0.1	0.6	0.0	0.0	1.6	0.6	0.0	0.0	0.1	100.0
PROJ YR												
1983	1.5	0.0	0.1	1.0	0.0	0.0	2.6	1.0	0.0	0.1	0.2	100.0
1987	2.5	0.0	0.2	1.6	0.0	0.1	4.3	1.6	0.1	0.1	0.3	100.0
1995	3.5	0.0	0.2	2.3	0.0	0.1	6.1	2.2	0.1	0.1	0.4	100.0
2005	3.6	0.0	0.3	2.4	0.0	0.1	6.3	2.3	0.1	0.1	0.5	100.0

STATIONARY SOURCE CATEGORIES

	POINT	AREA								STAT TOTAL	GRAND TOTAL
BASE YR											
1977	68.7	31.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	--
PROJ YR											
1983	70.5	29.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	--
1987	71.8	28.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	--
1995	74.1	25.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	--
2005	76.8	23.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	--

TABLE 8

CO : CONTRIBUTIONS RELATIVE TO TOTAL INVENTORY   SCENARIO : BASELINE

PERCENT OF TOTAL INVENTORY

MOBILE SOURCE CATEGORIES

	LDV-G	LDT1-G	LDT2-G	HDG	CYCLES	LDV-D	LDT1-D	LDT2-D	HDD	RAILROAD	VESSELS
BASE YR											
1977	57.3	6.9	4.4	14.9	0.5	0.0	0.0	0.0	1.5	0.2	0.4
PROJ YR											
1983	44.1	7.9	5.8	18.5	0.5	0.0	0.0	0.0	2.8	0.4	0.6
1987	34.5	7.7	6.5	16.9	0.3	0.0	0.0	0.0	4.8	0.6	0.9
1995	31.7	6.2	5.0	12.3	0.2	0.0	0.0	0.0	8.9	0.8	1.2
2005	33.2	6.5	3.7	8.6	0.2	0.0	0.0	0.0	13.8	0.8	1.3

	AIRCRAFT		OH-MCYC	FARM-G	LAWN	SNOW	INDMCH-G	CONST-G	FARM-D	INDMCH-D	CONST-D	MOBILE TOTAL
BASE YR												
1977	0.8	0.0	0.1	0.5	0.0	0.0	1.4	0.5	0.0	0.0	0.1	89.6
PROJ YR												
1983	1.3	0.0	0.1	0.9	0.0	0.0	2.3	0.8	0.0	0.0	0.2	86.2
1987	2.0	0.0	0.1	1.3	0.0	0.1	3.5	1.3	0.0	0.1	0.2	80.8
1995	2.8	0.0	0.2	1.8	0.0	0.1	4.8	1.7	0.1	0.1	0.3	78.2
2005	2.9	0.0	0.2	1.9	0.0	0.1	5.0	1.8	0.1	0.1	0.4	80.6

STATIONARY SOURCE CATEGORIES

	POINT	AREA								STAT TOTAL	GRAND TOTAL
BASE YR											
1977	7.2	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.4	100.0
PROJ YR											
1983	9.7	4.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.8	100.0
1987	13.8	5.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.2	100.0
1995	16.1	5.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.8	100.0
2005	14.9	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.4	100.0

Table 9
Mobile Sources of Pollution

Description	Designation
Light duty gas vehicles	LDV-G
Light duty gas trucks less than 6000 pounds	LDT1-G
Light duty gas trucks between 6000 and 8500 pounds	LDT2-G
Heavy duty gas trucks	HDG
Highway motorcycles	CYCLES
Heavy duty diesel trucks	HDD
Locomotives	RAILROAD
Vessels	VESSELS
Aircraft	AIRCRAFT
Off-highway motorcycles	OH-MCYC
Gas farm equipment	FARM-G
Lawn and garden equipment	LAWN
Snowmobiles	SNOW
Gas industrial machines	INSMCH-G
Gas construction equipment	CONST-G
Diesel farm equipment	FARM-D
Diesel industrial machines	INDMCH-D
Diesel construction equipment	CONST-D

Table 10
Stationary Sources of Pollution

Pollutant	Description	Designation
CO	Point sources	POINT
	Area sources	AREA
NMHC	Combustion	COMBUST
	Petroleum refineries	PETROL
	Petroleum storage	STORAGE
	Industrial processes	INDUST
	Solvent evaporation	SOLVENT
NOx	Point sources	POINT
	Residential oil and gas	RES-OIL
	Commercial coal	COM-COAL
	Commercial oil and gas	COM-OIL
	Institutional coal	IND-COAL
	Institutional oil and gas	IND-OIL
	Other area sources	OTHER

Table 11

Total CO Inventory - Scenario Summary

Scenario	Emissions Inventory in 1977 (tons)	Change from Base Case (Percent)	Emissions Inventory in 2005 (tons)	Change from 1977 (Percent)
Baseline	49800.5	0	18149.9	-63.6
Low temperature	58190.7	+16.8	19762.0	-66.0
Low retirement	49800.5	0	18149.9	-63.6
High retirement	49800.5	0	18149.9	-63.6
Rural	25939.4	-47.9	10875.2	-58.1
Urban	54878.5	+10.2	19991.0	-63.6
Low mobile source growth	49800.5	0	14603.7	-70.7
High mobile source growth	49800.5	0	28808.0	-42.2
Low stationary source growth	49800.5	0	16652.2	-66.6
High stationary source growth	49800.5	0	20691.7	-58.5
+50 LDV emission factors	64067.5	+28.6	21167.0	-67.0
+100 LDV emission factors	78333.2	+57.3	24182.4	-69.1

Table 12
Mobile Source CO Contribution - Scenario Summary

Scenario	Mobile Source Contribution in 1977 (Percent)	Change from Base Case (Percent)	Mobile Source Contribution in 2005 (Percent)	Change from 1977 (Percent)
Baseline	89.6	0	80.6	-10.0
Low temperature	91.1	+1.7	82.2	-9.8
Low retirement	89.6	0	80.6	-10.0
High retirement	89.6	0	80.6	-10.0
Rural	80.0	-10.7	67.6	-15.5
Urban	90.5	+1.0	82.4	-9.0
Low mobile source growth	89.6	0	75.9	-15.3
High mobile source growth	89.6	0	87.8	-2.0
Low stationary source growth	89.6	0	87.8	-2.0
High stationary source growth	89.6	0	70.7	-21.1
+50 LDV emission factors	91.1	+2.6	83.3	-9.4
+100 LDV emission factors	93.4	+4.2	85.4	-8.6

TABLE 13

NMHC : INVENTORY LEVELS SCENARIO : BASELINE

EMISSIONS (1000 TONS/YEAR)

MOBILE SOURCE CATEGORIES

	LDV-G	LDT1-G	LDT2-G	HDG	CYCLES	LDV-D	LDT1-D	LDT2-D	HDD	RAILROAD	VESSELS
BASE YR											
1977	3379.8	386.3	311.4	737.3	81.2	0.0	0.0	0.0	106.8	79.2	59.4
PROJ YR											
1983	1578.8	202.1	205.8	418.5	33.6	0.0	0.0	0.0	137.7	81.7	61.7
1987	820.7	128.4	133.9	252.8	7.7	0.0	0.0	0.0	127.5	85.8	64.3
1995	565.8	101.7	79.8	158.4	1.5	0.0	0.0	0.0	165.4	94.2	70.1
2005	625.2	112.7	65.4	126.2	2.0	0.0	0.0	0.0	258.1	104.3	78.5

	AIRCRAFT		OH-MCYC	FARM-G	LAWN	SNOW	INDMCH-G	CONST-G	FARM-D	INDMCH-D	CONST-D	MOBILE TOTAL
BASE YR												
1977	115.8	0.0	7.1	9.5	0.0	6.8	21.2	6.7	2.4	3.0	13.3	5327.1
PROJ YR												
1983	121.4	0.0	7.1	9.5	0.0	6.8	21.6	6.7	2.4	3.0	13.3	2921.2
1987	127.2	0.0	7.1	9.6	0.0	7.1	22.1	6.8	2.5	3.0	13.3	1833.5
1995	138.2	0.0	7.4	10.0	0.0	7.8	23.5	7.1	2.5	3.1	14.3	1457.9
2005	152.9	0.0	8.0	11.0	0.0	8.7	27.0	7.7	2.7	3.2	16.1	1620.8

STATIONARY SOURCE CATEGORIES

			COMBUST		PETROL	STORAGE	INDUST	SOLVENT		STAT TOTAL	GRAND TOTAL
BASE YR											
1977	0.0	0.0	302.5	0.0	226.6	1031.3	429.3	4033.3	0.0	6022.9	11350.0
PROJ YR											
1983	0.0	0.0	302.5	0.0	29.2	232.0	328.0	2252.1	0.0	3143.4	6064.6
1987	0.0	0.0	302.5	0.0	33.4	251.5	367.1	2173.4	0.0	3127.0	4960.5
1995	0.0	0.0	302.5	0.0	43.2	294.6	465.7	2084.0	0.0	3190.7	4648.6
2005	0.0	0.0	302.5	0.0	55.1	359.1	638.3	2092.5	0.0	3449.4	5070.1

TABLE 14

NMHC : RELATIVE CONTRIBUTIONS SCENARIO : BASELINE

PERCENT OF MOBILE/STATIONARY SOURCE CONTRIBUTION

MOBILE SOURCE CATEGORIES

	LDV-G	LDT1-G	LDT2-G	HDG	CYCLES	LDV-D	LDT1-D	LDT2-D	HDD	RAILROAD	VESSELS
BASE YR											
1977	63.4	7.3	5.8	13.8	1.5	0.0	0.0	0.0	2.0	1.5	1.1
PROJ YR											
1983	54.0	6.9	7.0	14.3	1.2	0.0	0.0	0.0	4.7	2.8	2.1
1987	44.8	7.0	7.3	13.8	0.4	0.0	0.0	0.0	7.0	4.7	3.5
1995	38.8	7.0	5.5	10.9	0.1	0.0	0.0	0.0	11.3	6.5	4.8
2005	38.6	7.0	4.0	7.8	0.1	0.0	0.0	0.0	15.9	6.4	4.8

	AIRCRAFT		OH-MCYC	FARM-G	LAWN	SNOW	INDMCH-G	CONST-G	FARM-D	INDMCH-D	CONST-D	MOBILE TOTAL
BASE YR												
1977	2.2	0.0	0.1	0.2	0.0	0.1	0.4	0.1	0.0	0.1	0.2	100.0
PROJ YR												
1983	4.2	0.0	0.2	0.3	0.0	0.2	0.7	0.2	0.1	0.1	0.5	100.0
1987	6.9	0.0	0.4	0.5	0.0	0.4	1.2	0.4	0.1	0.2	0.7	100.0
1995	9.5	0.0	0.5	0.7	0.0	0.5	1.6	0.5	0.2	0.2	1.0	100.0
2005	9.4	0.0	0.5	0.7	0.0	0.5	1.7	0.5	0.2	0.2	1.0	100.0

STATIONARY SOURCE CATEGORIES

			COMBUST		PETROL	STORAGE	INDUST	SOLVENT		STAT TOTAL	GRAND TOTAL
BASE YR											
1977	0.0	0.0	5.0	0.0	3.8	17.1	7.1	67.0	0.0	100.0	--
PROJ YR											
1983	0.0	0.0	9.6	0.0	0.9	7.4	10.4	71.6	0.0	100.0	--
1987	0.0	0.0	9.7	0.0	1.1	8.0	11.7	69.5	0.0	100.0	--
1995	0.0	0.0	9.5	0.0	1.4	9.2	14.6	65.3	0.0	100.0	--
2005	0.0	0.0	8.8	0.0	1.6	10.4	18.5	60.7	0.0	100.0	--

TABLE 15

NMHC : CONTRIBUTIONS RELATIVE TO TOTAL INVENTORY SCENARIO : BASELINE

PERCENT OF TOTAL INVENTORY

MOBILE SOURCE CATEGORIES

	LDV-G	LDT1-G	LDT2-G	HDG	CYCLES	LDV-D	LDT1-D	LDT2-D	HDD	RAILROAD	VESSELS
BASE YR											
1977	29.8	3.4	2.7	6.5	0.7	0.0	0.0	0.0	0.9	0.7	0.5
PROJ YR											
1983	26.0	3.3	3.4	6.9	0.6	0.0	0.0	0.0	2.3	1.3	1.0
1987	16.5	2.6	2.7	5.1	0.2	0.0	0.0	0.0	2.6	1.7	1.3
1995	12.2	2.2	1.7	3.4	0.0	0.0	0.0	0.0	3.6	2.0	1.5
2005	12.3	2.2	1.3	2.5	0.0	0.0	0.0	0.0	5.1	2.1	1.5

	AIRCRAFT		OH-MCYC	FARM-G	LAWN	SNOW	INDMCH-G	CONST-G	FARM-D	INDMCH-D	CONST-D	MOBILE TOTAL
BASE YR												
1977	1.0	0.0	0.1	0.1	0.0	0.1	0.2	0.1	0.0	0.0	0.1	46.9
PROJ YR												
1983	2.0	0.0	0.1	0.2	0.0	0.1	0.4	0.1	0.0	0.0	0.2	48.2
1987	2.6	0.0	0.1	0.2	0.0	0.1	0.4	0.1	0.1	0.1	0.3	37.0
1995	3.0	0.0	0.2	0.2	0.0	0.2	0.5	0.2	0.1	0.1	0.3	31.4
2005	3.0	0.0	0.2	0.2	0.0	0.2	0.5	0.2	0.1	0.1	0.3	32.0

STATIONARY SOURCE CATEGORIES

			COMBUST		PETROL	STORAGE	INDUST	SOLVENT		STAT TOTAL	GRAND TOTAL
BASE YR											
1977	0.0	0.0	2.7	0.0	2.0	9.1	3.8	35.5	0.0	53.1	100.0
PROJ YR											
1983	0.0	0.0	5.0	0.0	0.5	3.8	5.4	37.1	0.0	51.8	100.0
1987	0.0	0.0	6.1	0.0	0.7	5.1	7.4	43.8	0.0	63.0	100.0
1995	0.0	0.0	6.5	0.0	0.9	6.3	10.0	44.8	0.0	68.6	100.0
2005	0.0	0.0	6.0	0.0	1.1	7.1	12.6	41.3	0.0	68.0	100.0

Table 16
Total NMHC Inventory - Scenario Summary

Scenario	Emissions Inventory in 1977 (Tons)	Change from Base Case (Percent)	Emissions Inventory in 2005 (Tons)	Change from 1977 (Percent)
Baseline	11350.0	0	5070.1	-55.3
Low temperature	11833.1	+4.3	5230.0	-55.8
Low retirement	11350.0	0	5305.3	-53.3
High retirement	11350.0	0	4892.7	-56.9
Rural	9299.4	-18.1	4308.5	-53.7
Urban	11785.0	+3.8	5248.8	-55.5
Low mobile source growth	11350.0	0	4678.1	-58.8
High mobile source growth	11350.0	0	6251.5	-44.9
Low stationary source growth	11350.0	0	3903.3	-65.6
High stationary source growth	11350.0	0	7049.4	-37.9
+50 LDV emission factors	12529.9	+10.4	5349.0	-57.3
+100 LDV emission factors	13709.1	+20.8	5582.5	-59.3
Low stationary source control	11350.0	0	8670.1	-23.6

Table 17
Mobile Source NMHC Contributions - Scenario Summary

Scenario	Mobile Source Contribution in 1977	Change from Base Case (Percent)	Mobile Source Contribution in 2005	Change from 1977 (Percent)
Baseline	46.9	0	32.0	-31.8
Low temperature	49.1	+2.7	34.0	-30.8
Low retirement	46.9	0	30.6	-34.8
High retirement	46.9	0	33.1	-29.4
Rural	35.2	-24.9	19.9	-43.5
Urban	48.9	+4.3	34.3	-29.9
Low mobile source growth	46.9	0	26.3	-43.9
High mobile source growth	46.9	0	44.8	-4.5
Low stationary source growth	46.9	0	23.0	-11.5
High stationary source growth	46.9	0	23.0	-51.0
+50 LDV emission factors	51.9	+10.7	35.5	-31.6
+100 LDV emission factors	56.1	+19.6	38.2	-31.9
Low stationary source control	46.9	0	18.7	-60.1

TABLE 18

NOX : INVENTORY LEVELS — SCENARIO : BASELINE

EMISSIONS (1000 TONS/YEAR)

MOBILE SOURCE CATEGORIES

	LDV-G	LDT1-G	LDT2-G	HDG	CYCLES	LDV-D	LDT1-D	LDT2-D	HDD	RAILROAD	VESSELS
BASE YR											
1977	1536.6	202.3	158.7	300.6	0.1	0.0	0.0	0.0	523.2	325.1	62.9
PROJ YR											
1983	1076.4	147.7	112.4	240.7	0.4	0.0	0.0	0.0	679.1	343.8	66.2
1987	951.1	125.0	86.0	185.7	0.2	0.0	0.0	0.0	552.9	359.1	68.8
1995	974.4	116.0	69.8	135.0	0.1	0.0	0.0	0.0	376.5	389.3	75.3
2005	1076.0	129.3	74.2	115.3	0.2	0.0	0.0	0.0	552.8	429.6	82.7

	AIRCRAFT		OH-MCYC	FARM-G	LAWN	SNOW	INDMCH-G	CONST-G	FARM-D	INDMCH-D	CONST-D	MOBILE TOTAL
BASE YR												
1977	79.6	0.0	0.0	7.9	0.0	0.0	16.7	6.4	26.2	71.4	200.8	3518.4
PROJ YR												
1983	83.2	0.0	0.0	7.9	0.0	0.0	16.9	6.4	26.6	73.0	211.6	3103.1
1987	87.1	0.0	0.0	7.9	0.0	0.0	17.3	6.5	27.5	77.9	221.8	2780.3
1995	94.3	0.0	0.0	8.4	0.0	0.0	18.4	6.8	29.2	85.0	240.0	2627.4
2005	104.6	0.0	0.0	9.0	0.0	0.0	20.8	7.4	33.2	94.2	265.1	3003.9

STATIONARY SOURCE CATEGORIES

	POINT		RES-OIL	COM-COAL	COM-OIL	IND-COAL	IND-OIL	OTHER		STAT TOTAL	GRAND TOTAL
BASE YR											
1977	2838.0	0.0	180.8	3.7	174.3	29.1	113.0	46.6	0.0	3385.5	6903.9
PROJ YR											
1983	2445.9	0.0	184.3	3.4	110.8	25.3	71.8	47.4	0.0	2889.8	5992.9
1987	2685.4	0.0	188.7	3.5	114.5	26.4	74.6	49.8	0.0	3143.6	5923.9
1995	3240.6	0.0	196.5	3.6	121.3	27.9	78.0	54.5	0.0	3726.5	6353.9
2005	4107.9	0.0	208.7	3.7	133.7	29.8	87.6	61.1	0.0	4632.1	7636.1

TABLE 19

NOX : RELATIVE CONTRIBUTIONS SCENARIO : BASELINE

PERCENT OF MOBILE/STATIONARY SOURCE CONTRIBUTION

MOBILE SOURCE CATEGORIES

	LDV-G	LDT1-G	LDT2-G	HDG	CYCLES	LDV-D	LDT1-D	LDT2-D	HDD	RAILROAD	VESSELS
BASE YR											
1977	43.7	5.7	4.5	8.5	0.0	0.0	0.0	0.0	14.9	9.2	1.8
PROJ YR											
1983	34.7	4.8	3.6	7.8	0.0	0.0	0.0	0.0	21.9	11.1	2.1
1987	34.2	4.5	3.1	6.7	0.0	0.0	0.0	0.0	19.9	12.9	2.5
1995	37.1	4.4	2.7	5.1	0.0	0.0	0.0	0.0	14.3	14.8	2.9
2005	35.8	4.3	2.5	3.8	0.0	0.0	0.0	0.0	18.4	14.3	2.8

	AIRCRAFT		OH-MCYC	FARM-G	LAWN	SNOW	INDMCH-G	CONST-G	FARM-D	INDMCH-D	CONST-D	MOBILE TOTAL
BASE YR												
1977	2.3	0.0	0.0	0.2	0.0	0.0	0.5	0.2	0.7	2.0	5.7	100.0
PROJ YR												
1983	2.7	0.0	0.0	0.3	0.0	0.0	0.5	0.2	0.9	2.4	6.8	100.0
1987	3.1	0.0	0.0	0.3	0.0	0.0	0.6	0.2	1.0	2.8	8.0	100.0
1995	3.6	0.0	0.0	0.3	0.0	0.0	0.7	0.3	1.1	3.2	9.1	100.0
2005	3.5	0.0	0.0	0.3	0.0	0.0	0.7	0.2	1.1	3.1	8.8	100.0

STATIONARY SOURCE CATEGORIES

	POINT		RES-OIL	COM-COAL	COM-OIL	IND-COAL	IND-OIL	OTHER		STAT TOTAL	GRAND TOTAL
BASE YR											
1977	83.8	0.0	5.3	0.1	5.1	0.9	3.3	1.4	0.0	100.0	--
PROJ YR											
1983	84.6	0.0	6.4	0.1	3.8	0.9	2.5	1.6	0.0	100.0	--
1987	85.4	0.0	6.0	0.1	3.6	0.8	2.4	1.6	0.0	100.0	--
1995	87.0	0.0	5.3	0.1	3.3	0.7	2.1	1.5	0.0	100.0	--
2005	88.7	0.0	4.5	0.1	2.9	0.6	1.9	1.3	0.0	100.0	--

TABLE 20

NOX : CONTRIBUTIONS RELATIVE TO TOTAL INVENTORY SCENARIO : BASELINE

PERCENT OF TOTAL INVENTORY

MOBILE SOURCE CATEGORIES

	LDV-G	LDT1-G	LDT2-G	HDG	CYCLES	LDV-D	LDT1-D	LDT2-D	HDD	RAILROAD	VESSELS
BASE YR											
1977	22.3	2.9	2.3	4.4	0.0	0.0	0.0	0.0	7.6	4.7	0.9
PROJ YR											
1983	18.0	2.5	1.9	4.0	0.0	0.0	0.0	0.0	11.3	5.7	1.1
1987	16.1	2.1	1.5	3.1	0.0	0.0	0.0	0.0	9.3	6.1	1.2
1995	15.3	1.8	1.1	2.1	0.0	0.0	0.0	0.0	5.9	6.1	1.2
2005	14.1	1.7	1.0	1.5	0.0	0.0	0.0	0.0	7.2	5.6	1.1

	AIRCRAFT		OH-MCYC	FARM-G	LAWN	SNOW	INDMCH-G	CONST-G	FARM-D	INDMCH-D	CONST-D	MOBILE TOTAL
BASE YR												
1977	1.2	0.0	0.0	0.1	0.0	0.0	0.2	0.1	0.4	1.0	2.9	51.0
PROJ YR												
1983	1.4	0.0	0.0	0.1	0.0	0.0	0.3	0.1	0.4	1.2	3.5	51.8
1987	1.5	0.0	0.0	0.1	0.0	0.0	0.3	0.1	0.5	1.3	3.7	46.9
1995	1.5	0.0	0.0	0.1	0.0	0.0	0.3	0.1	0.5	1.3	3.8	41.4
2005	1.4	0.0	0.0	0.1	0.0	0.0	0.3	0.1	0.4	1.2	3.5	39.3

STATIONARY SOURCE CATEGORIES

	POINT		RES-OIL	COM-COAL	COM-OIL	IND-COAL	IND-OIL	OTHER		STAT TOTAL	GRAND TOTAL
BASE YR											
1977	41.1	0.0	2.6	0.1	2.5	0.4	1.6	0.7	0.0	49.0	100.0
PROJ YR											
1983	40.8	0.0	3.1	0.1	1.8	0.4	1.2	0.8	0.0	48.2	100.0
1987	45.3	0.0	3.2	0.1	1.9	0.4	1.3	0.8	0.0	53.1	100.0
1995	51.0	0.0	3.1	0.1	1.9	0.4	1.2	0.9	0.0	58.6	100.0
2005	53.8	0.0	2.7	0.0	1.8	0.4	1.1	0.8	0.0	60.7	100.0

Table 21
Total NOx Inventory - Scenario Summary

Scenario	Emissions Inventory in 1977 (Tons)	Change from Base Case (Percent)	Emissions Inventory in 2005 (Tons)	Change from 1977 (Percent)
Baseline	6903.9	0	7636.1	+10.6
Low temperature	6903.9	0	7636.1	+10.6
Low retirement	6903.9	0	7709.1	+11.8
High retirement	6903.9	0	7571.6	+9.7
Rural	7103.2	+2.9	7894.4	+11.1
Urban	6803.2	-0.6	7584.0	+10.5
Low mobile source growth	6903.9	0	6909.4	+0.1
High mobile source growth	6903.9	0	9816.2	+42.2
Low stationary source growth	6903.9	0	5780.1	-16.3
High stationary source growth	6903.9	0	10778.3	+56.1
+50 LDV emission factors	7672.1	+11.1	8174.0	+6.5
+100 LDV emission factors	8441.5	+22.3	8712.9	+3.2

Table 22
Mobile Source NOx Contributions - Scenario Summary

Scenario	Mobile Source in 1977 (Percent)	Change from Base Case (Percent)	Mobile Source Contribution in 2005 (Percent)	Change from 1977 (Percent)
Baseline	51.0	0	39.3	-22.9
Low temperature	51.0	0	39.3	-22.9
Low retirement	51.0	0	38.9	-23.7
High retirement	51.0	0	39.7	-22.2
Rural	52.3	+2.5	41.3	-21.0
Urban	50.7	-0.6	38.9	-23.3
Low mobile source growth	51.0	0	33.0	-35.3
High mobile source growth	51.0	0	52.8	+3.5
Low stationary source growth	51.0	0	51.9	+1.8
High stationary source growth	51.0	0	27.9	-45.3
+50 LDV emission factors	55.9	+9.6	43.3	-22.5
+100 LDV emission factors	59.9	+17.5	46.8	-21.9

List of Figures

FIGURE 1 DISTRIBUTION OF MOBILE SOURCE CO EMISSIONS

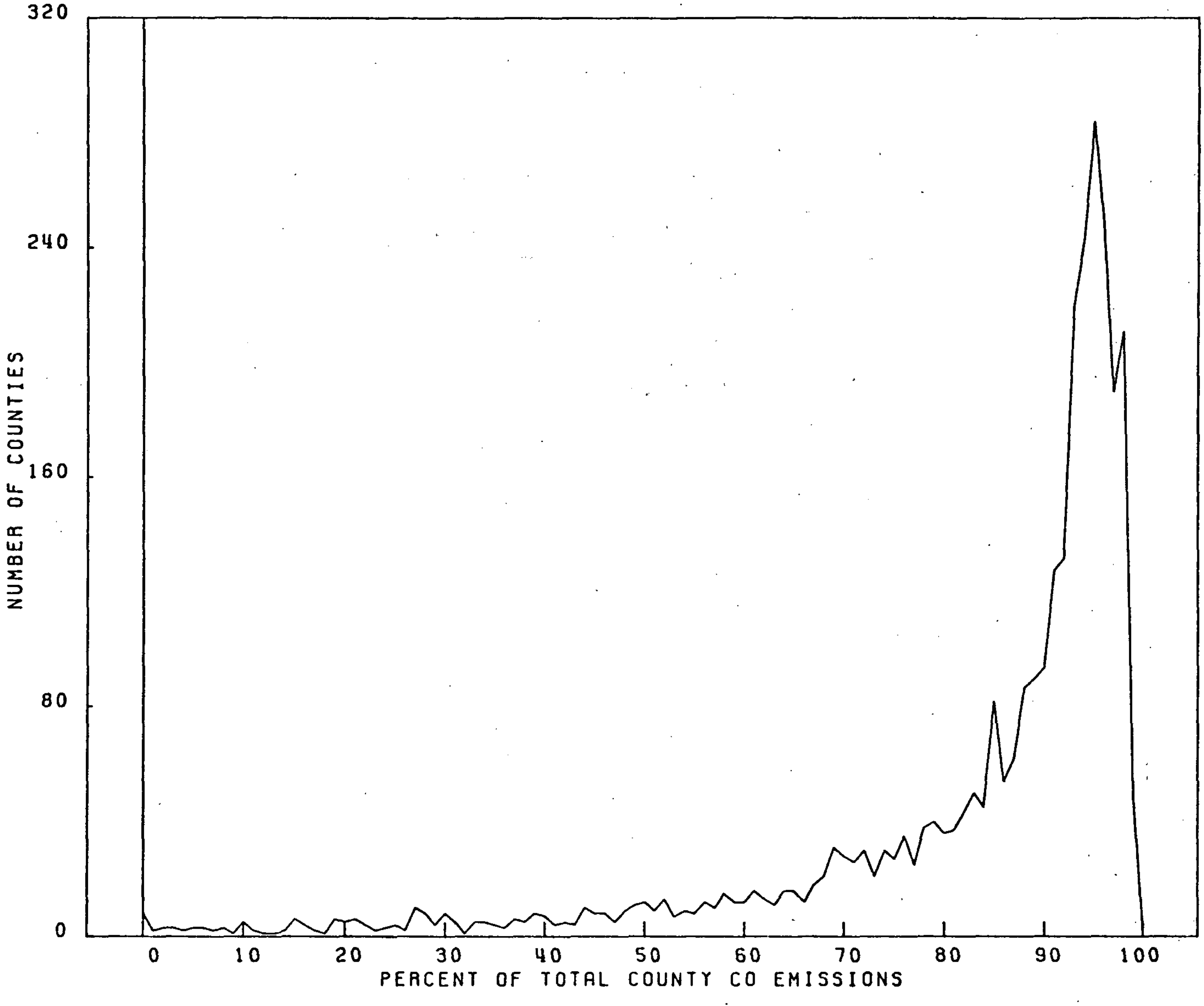


FIGURE 2 DISTRIBUTION OF MOBILE SOURCE HC EMISSIONS

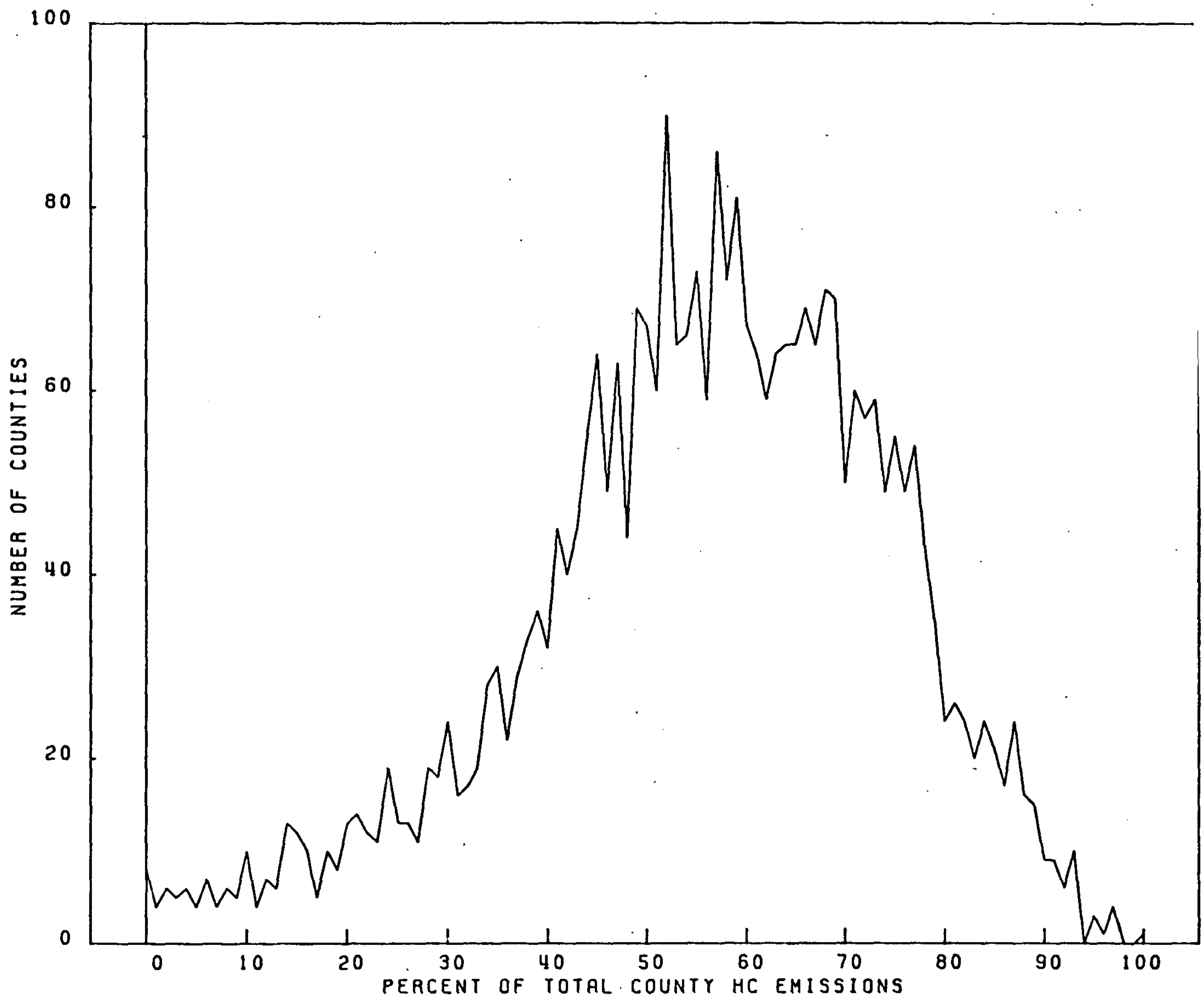


FIGURE 3 DISTRIBUTION OF MOBILE SOURCE NOX EMISSIONS

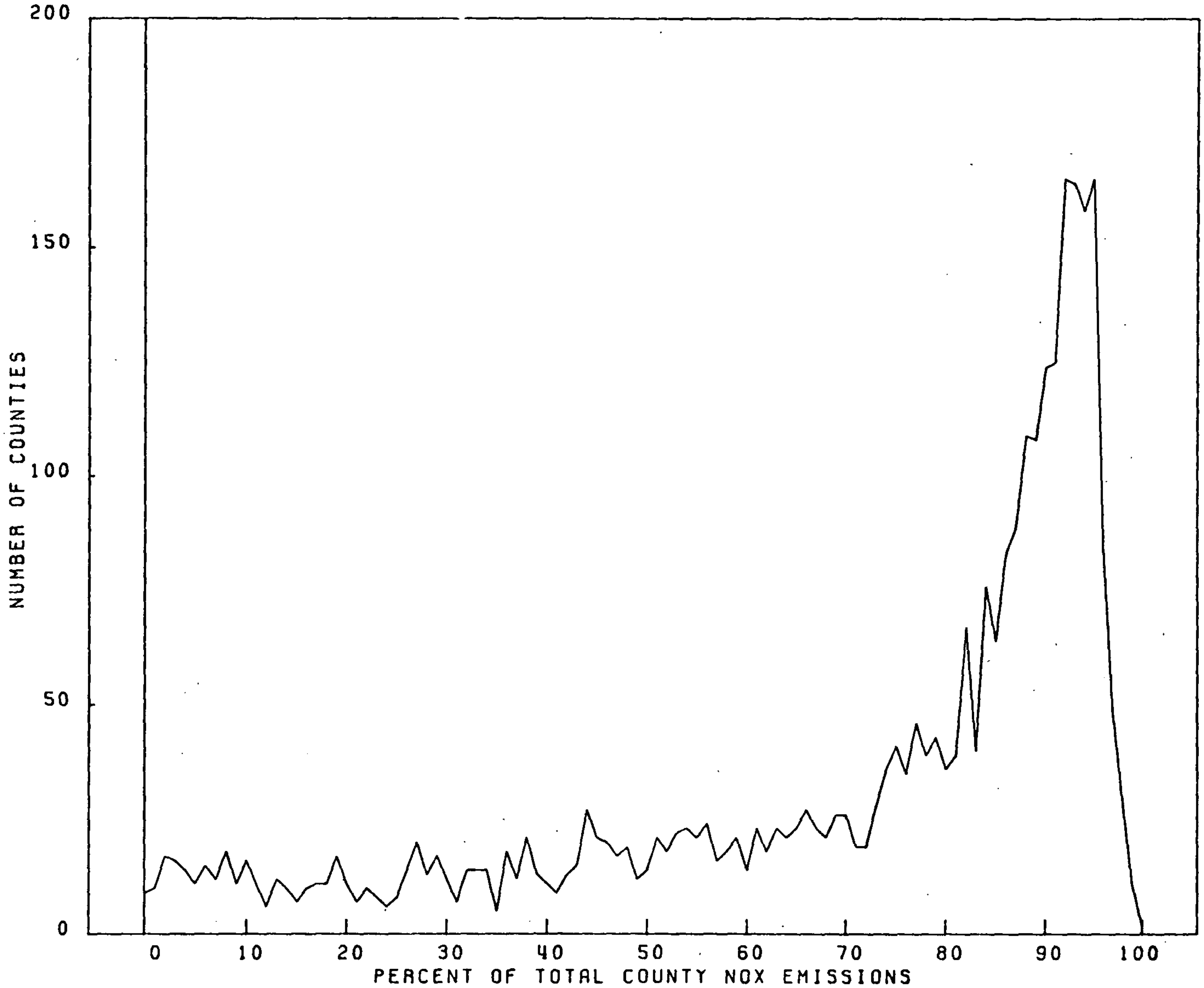


FIGURE 4 DISTRIBUTION OF MOBILE SOURCE CO EMISSIONS

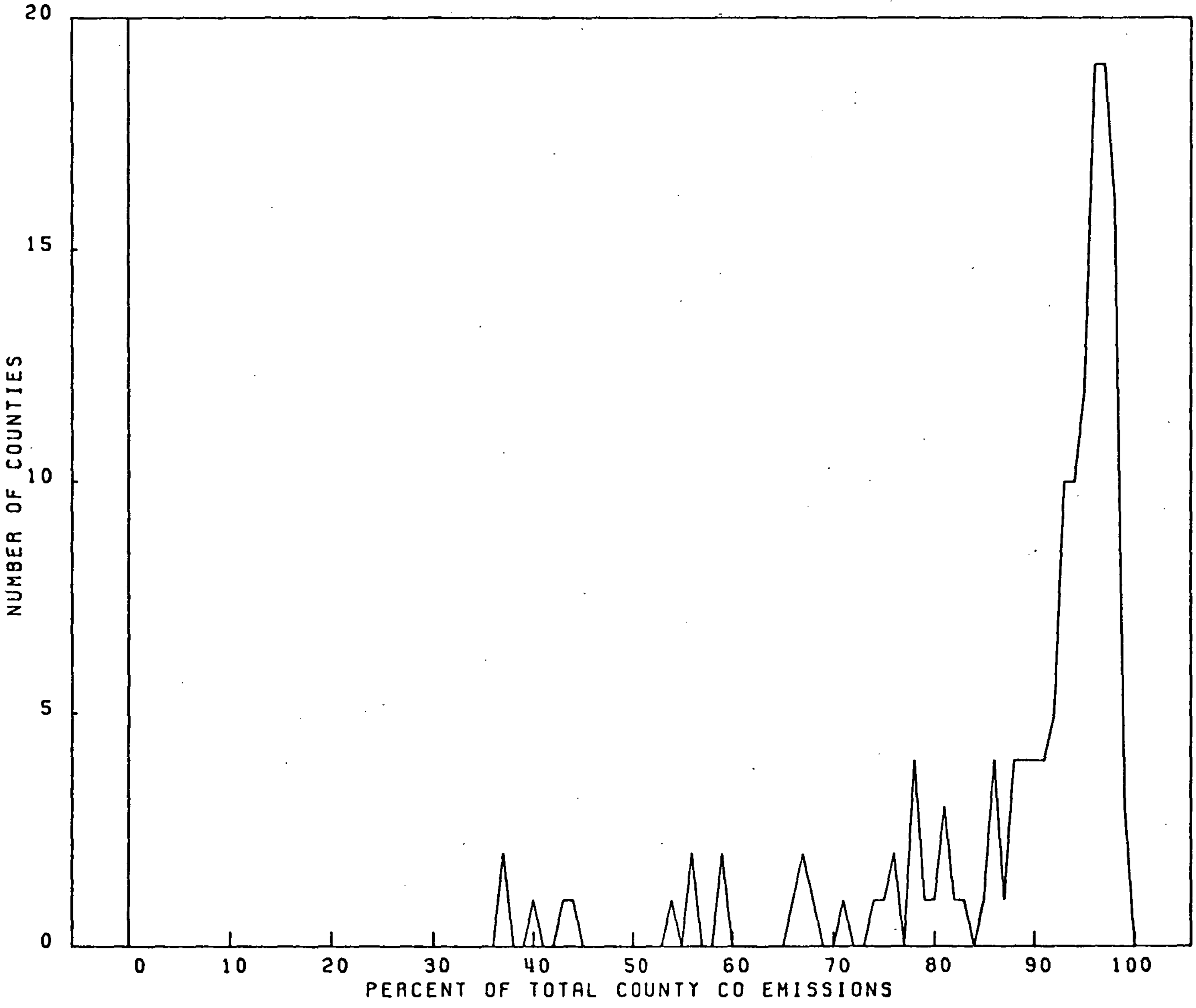


FIGURE 5 DISTRIBUTION OF MOBILE SOURCE HC EMISSIONS

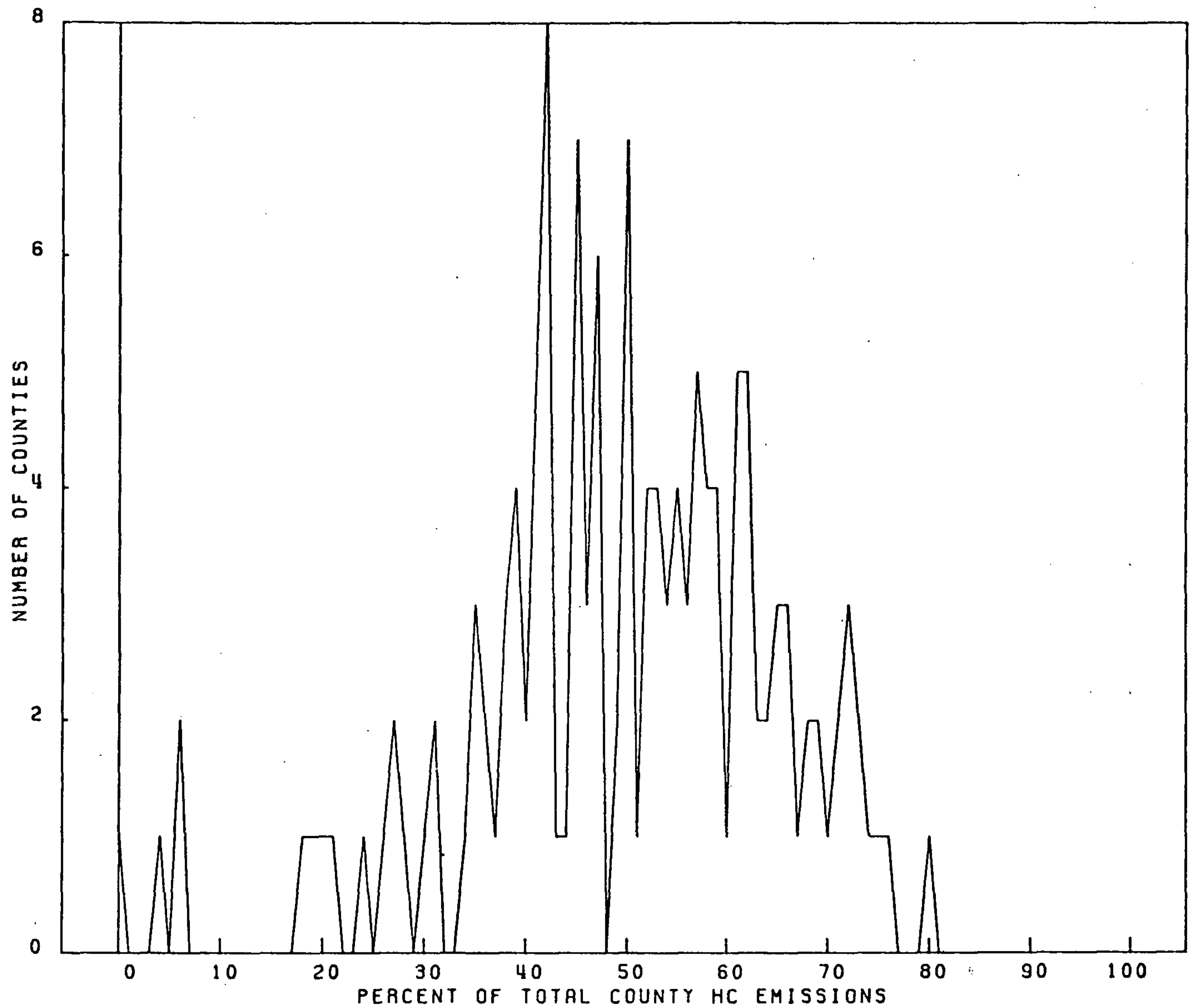


FIGURE 6 DISTRIBUTION OF MOBILE SOURCE NOX EMISSIONS

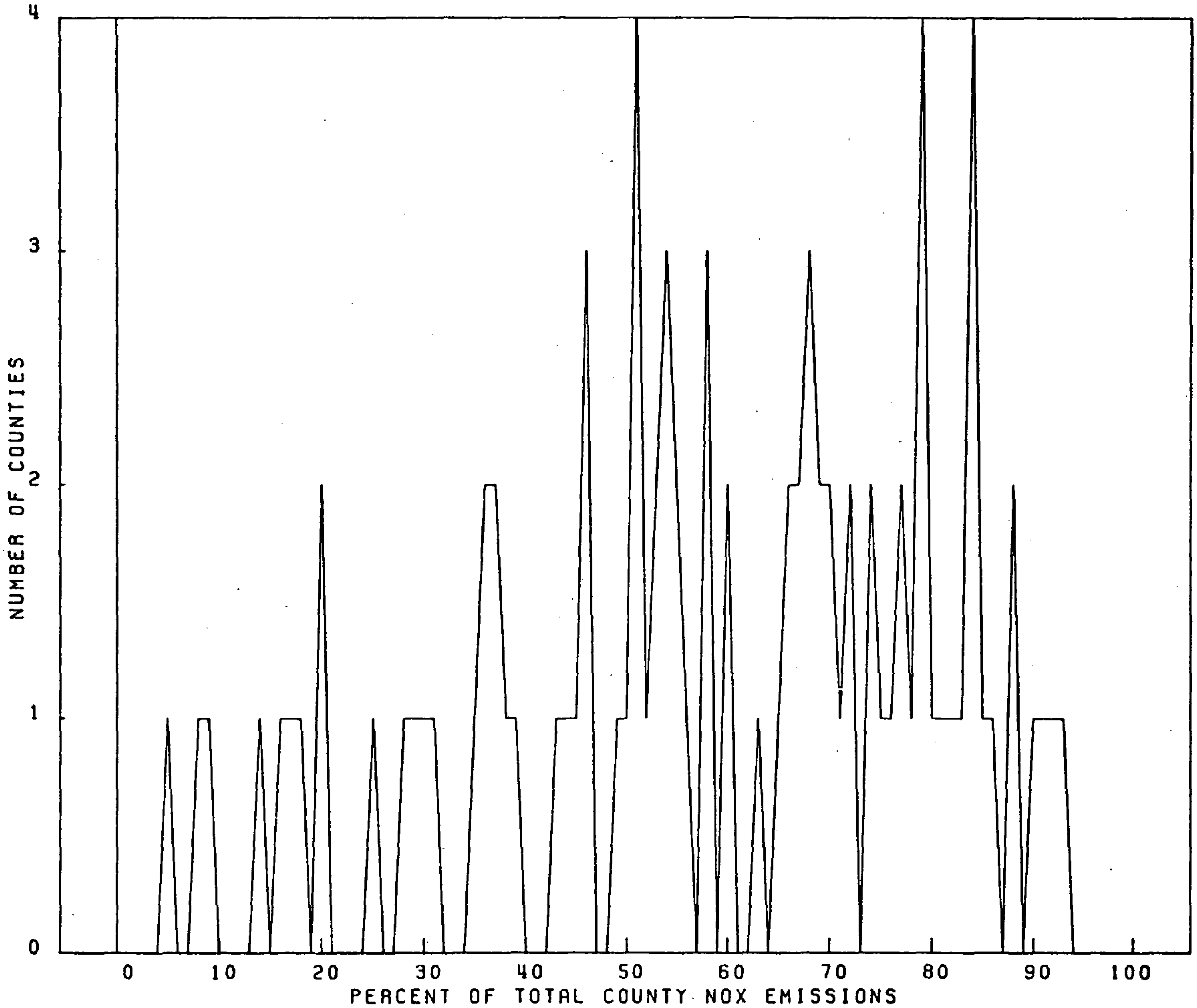


FIGURE 7
CO - BASELINE

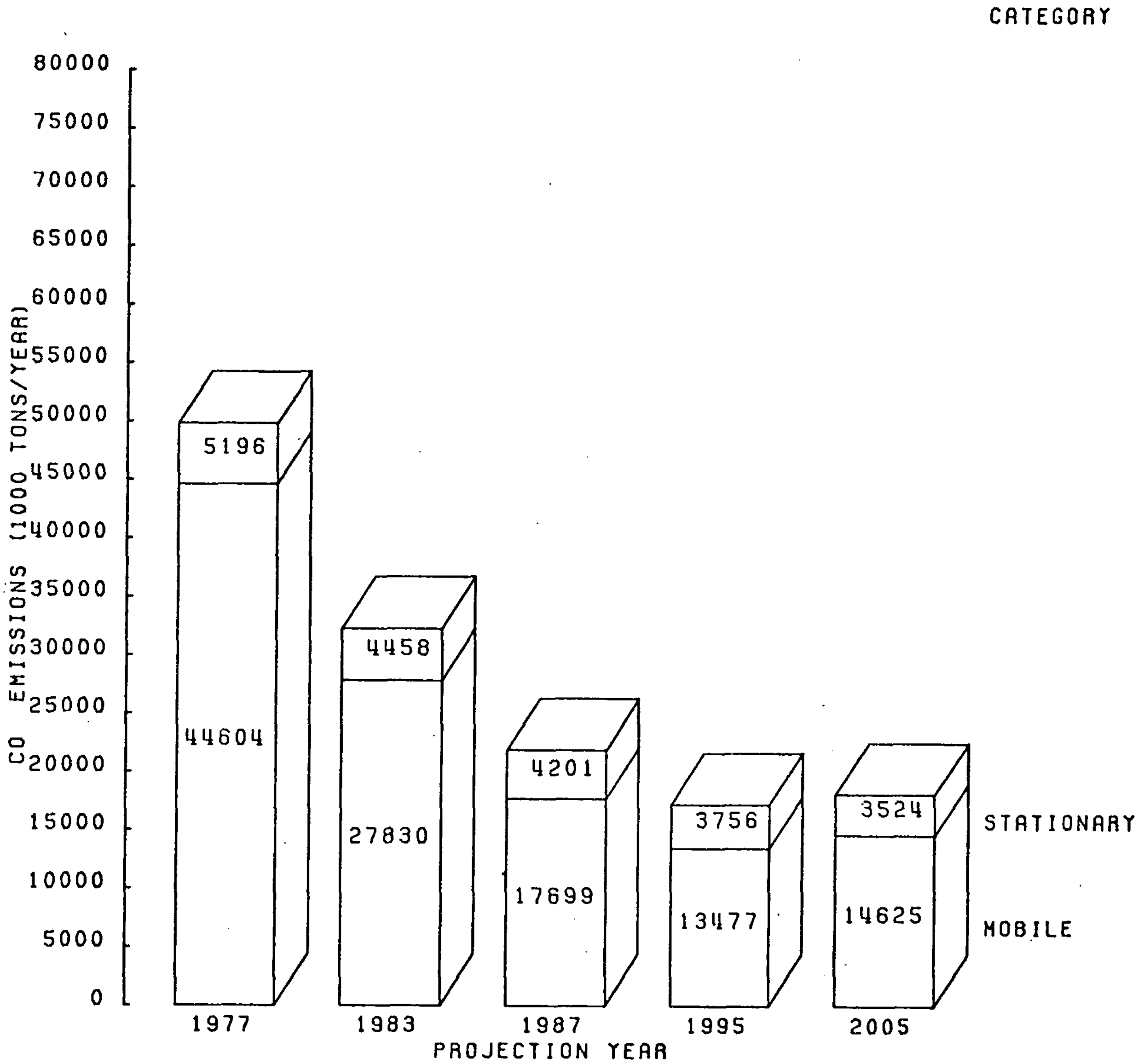


FIGURE 8
CO - BASELINE

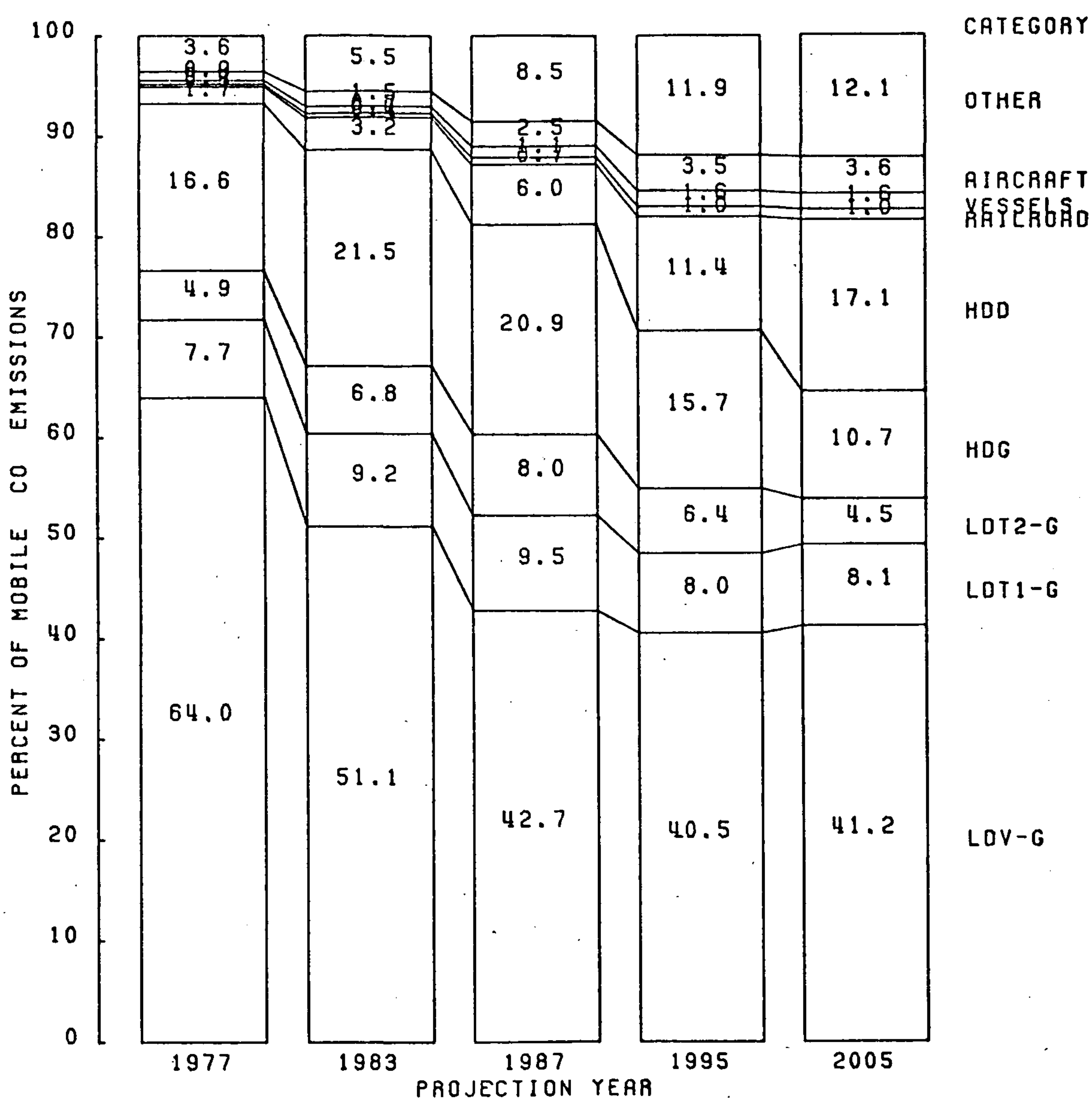
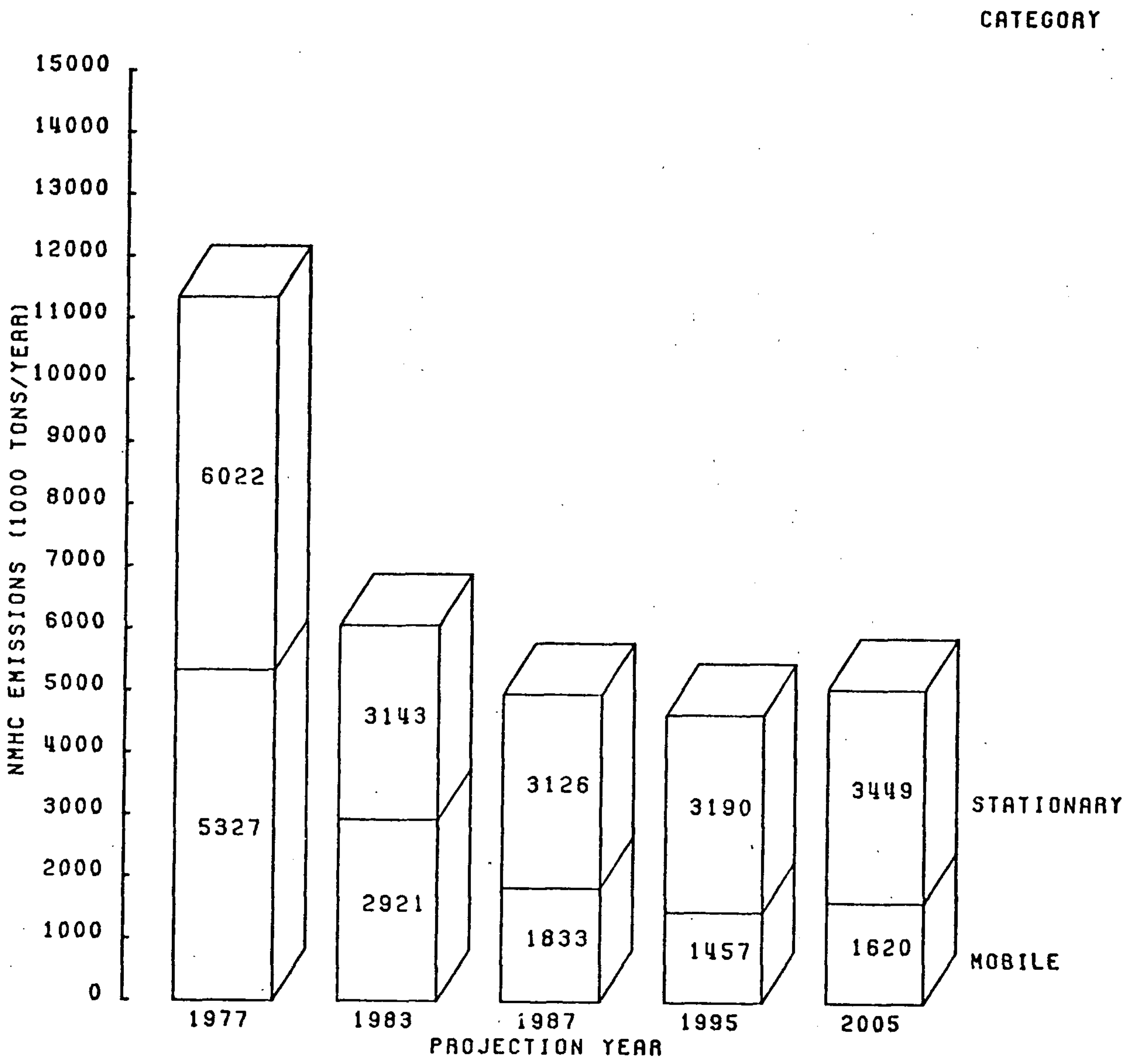


FIGURE 9
NMHC - BASELINE



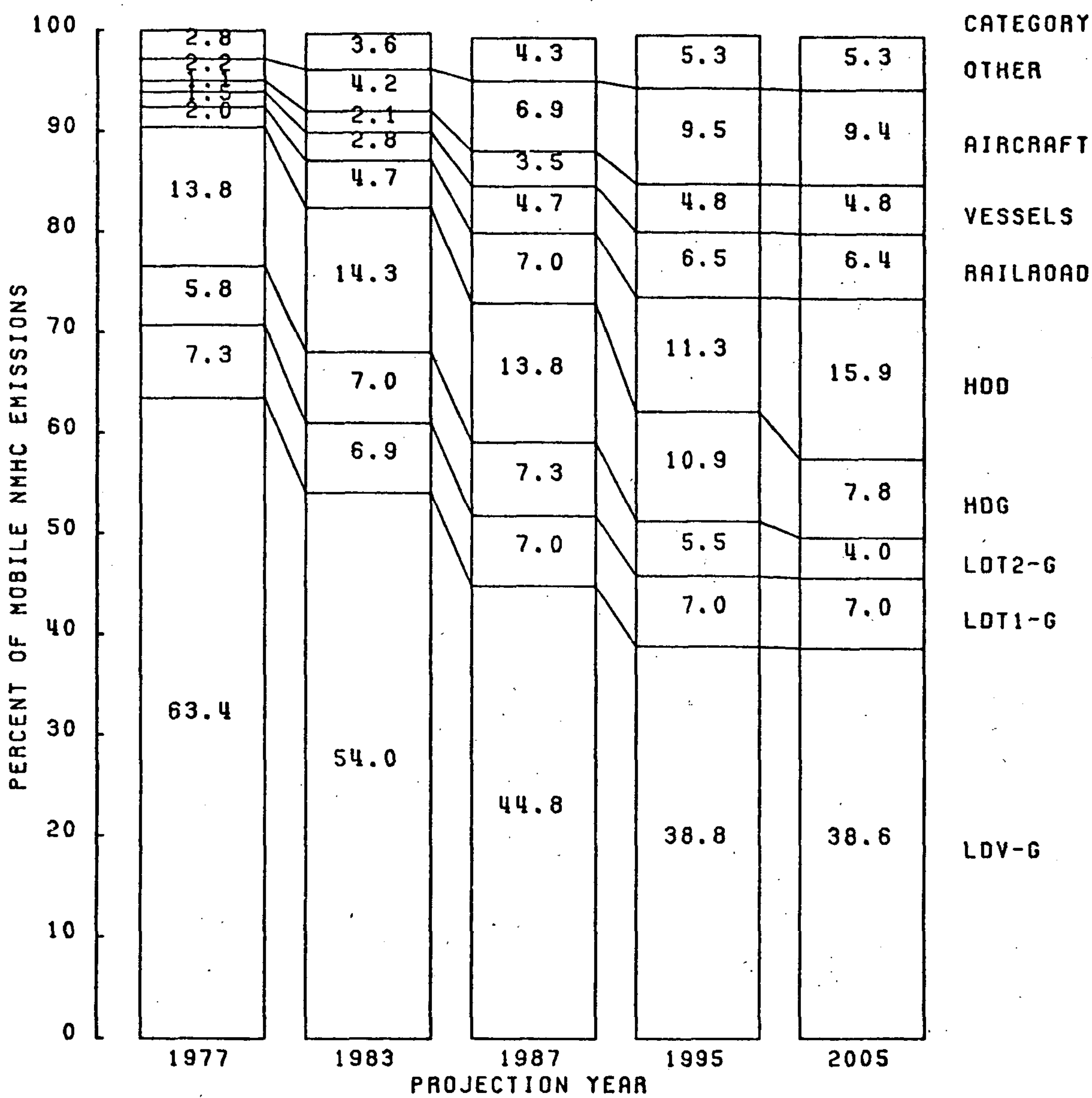


FIGURE 10
NMHC - BASELINE

FIGURE 12
NOX - BASELINE

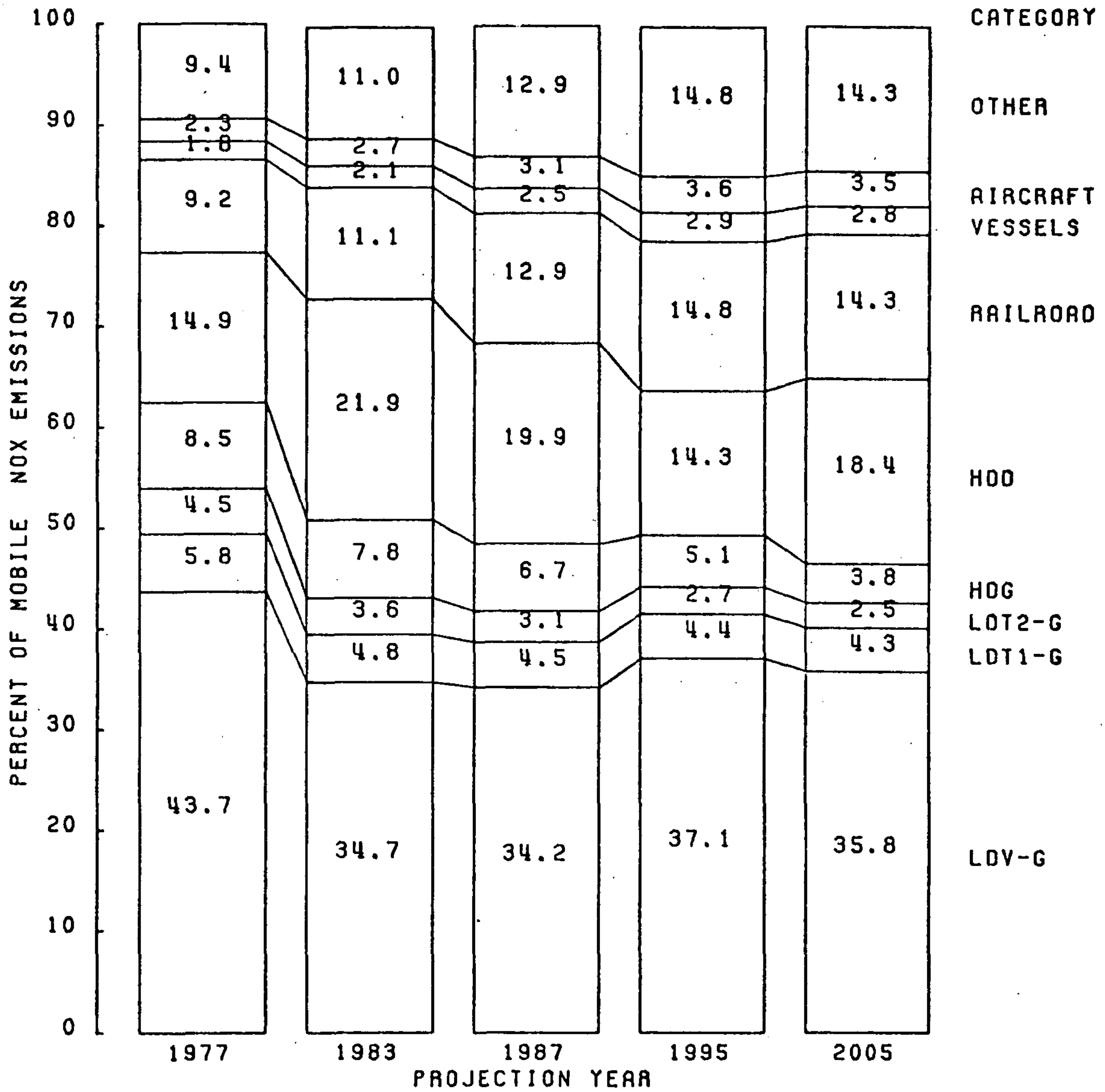
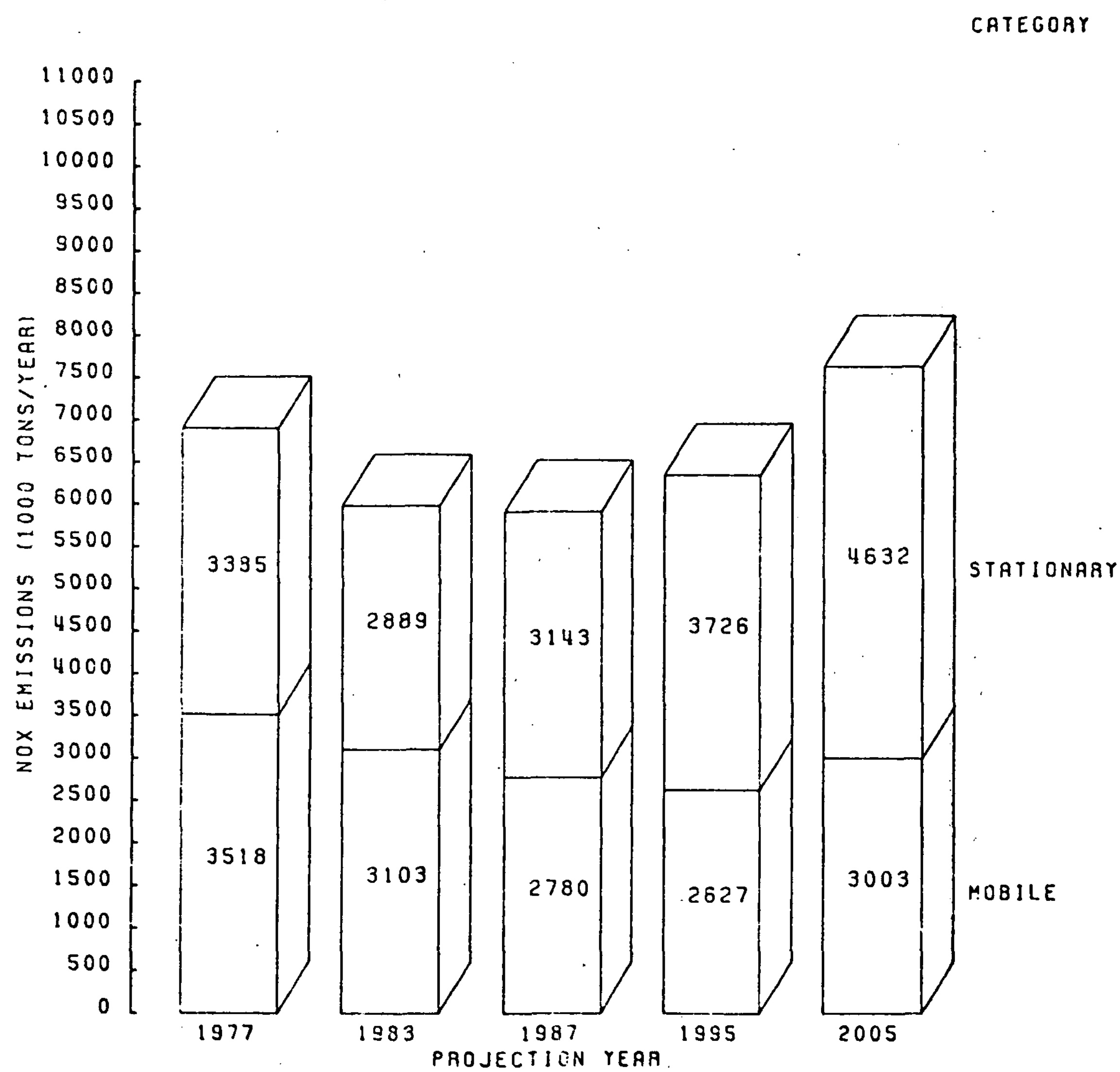


FIGURE 11
NOX - BASELINE



Appendix A

Counties with the Potential to Violate the Current CO, NO_2 and O_3 NAAQS

COUNTIES WITH THE POTENTIAL TO VIOLATE CURRENT CO, NO_2, AND O_3 AMBIENT STANDARDS

	State	County Code	AQCR	County Name	State	CO	NO2	Ozone
27	05	7700	030	Solano	CA	X		X
28	05	8020	031	Stanislaus	CA	X	X	X
29	05	8340	031	Tulare	CA	X	X	X
30	05	8840	028	Yolo	CA	X		X
31	06	0020	036	Adams	CO	X		X
32	06	0080	036	Arapahoe	CO	X		X
33	06	0220	036	Boulder	CO	X		X
34	06	0600	036	Denver	CO	X	X	X
35	06	0760	038	El Paso	CO	X		
36	06	1140	036	Jefferson	CO	X		X
37	06	1320	037	Larimer	CO	X		
38	06	2220	037	Weld	CO	X		
39	07	0265	042,043	Fairfield	CT	X	X	X
40	07	0425	042	Hartford	CT	X	X	X
41	07	0705	042	New Haven	CT	X	X	X
42	07	0725	041	New London	CT			X
43	09	0020	047	Washington	DC	X	X	X
44	10	0420	050	Broward	FL	X	X	
45	10	1080	049	Duval	FL	X		X
46	10	1800	052	Hillsbourough	FL		X	X
47	11	2260	056	Fulton	GA	X	X	X
48	13	0020	064	Ada	ID	X		
49	14	1540	067	Cook	IL	X	X	X
50	14	8320	067	Will	IL		X	X
51	14	8400	073	Winnebago	IL			X
52	15	0060	081	Allen	IN			X
53	15	2360	067	Lake	IN	X	X	X

COUNTIES WITH THE POTENTIAL TO VIOLATE

CURRENT CO, NO_2, AND O_3 AMBIENT STANDARDS

	State	County Code	AQCR	County Name	State	CO	NO2	Ozone
1	01	1980	004	Jefferson	AL	X	X	X
2	01	2400	005	Mobile	AL			X
3	01	2480	002	Montgomery	AL			X
4	02	0060	008	Anchorage	AK	X		
5	02	0180	009	Fairbanks	AK	X		
6	03	0440	015	Maricopa	AZ	X	X	X
7	03	0620	015	Pima	AZ	X	X	X
8	04	2220	016	Pulaski	AR			X
9	05	0060	030	Alameda	CA	X	X	X
10	05	0960	028	Butte	CA	X		X
11	05	1620	030	Contra Costa	CA		X	X
12	05	2820	031	Fresno	CA	X	X	X
13	05	3480	031, 033	Kern	CA	X	X	X
14	05	4200	024, 033	Los Angeles	CA	X	X	X
15	05	4400	030	Marin	CA	X		X
16	05	4600	031	Merced	CA	X		X
17	05	5440	024	Orange	CA		X	X
18	05	6420	024, 033	Riverside	CA	X	X	X
19	05	6600	028	Sacramento	CA	X	X	X
20	05	6680	024, 033	San Bernardino	CA		X	X
21	05	6820	029, 033	San Diego	CA	X	X	X
22	05	6880	030	San Francisco	CA	X	X	X
23	05	6960	031	San Joaquin	CA	X		X
24	05	7120	030	San Mateo	CA	X	X	X
25	05	7220	024, 032	Santa Barbara	CA	X	X	X
26	05	7260	030	Santa Clara	CA	X	X	X

COUNTIES WITH THE POTENTIAL TO VIOLATE CURRENT CO, NO_2, AND O_3 AMBIENT STANDARDS

	State	County Code	AQCR	County Name	State	CO	NO2	Ozone
54	15	2640	080	Marion	IN	X	X	X
55	15	3700	082	St. Joseph	IN			X
56	16	2280	088	Linn	IA	X		
57	16	3120	092	Polk	IA	X	X	
58	16	3280	069	Scott	IA	X		
59	17	0860	095	Douglas	KS	X		
60	17	3320	099	Sedgwick	KS	X		X
61	18	0340	103	Boyd	KY		X	
62	18	0920	077	Daviess	KY	X		
63	18	1920	078	Jefferson	KY	X	X	X
64	18	2460	072	McCracken	KY	X		
65	19	0500	022	Caddo	LA			X
66	20	0027	107	Androscoggin	ME	X		
67	20	0907	109	Penobscot	ME	X		
68	21	0040	113	Allegany	MD	X		
69	21	0080	115	Anne Arundel	MD	X	X	X
70	21	0120	115	Baltimore City	MD	X	X	X
71	21	0140	115	Baltimore County	MD		X	X
72	21	1160	047	Montgomery	MD	X		X
73	21	1300	047	Prince George's	MD	X		X
74	21	1680	113	Washington	MD	X		
75	22	0369	118	Central Mass	MA	X		X
76	22	1274	121	Merrimack	MA	X		X
77	22	1291	119	Metro Boston	MA	X	X	X
78	22	1798	042	Pioneer Valley	MA		X	X
79	23	2360	125	Ingham	MI		X	
80	23	2720	122	Kent	MI		X	X

COUNTIES WITH THE POTENTIAL TO VIOLATE

CURRENT CO, NO_2, AND O_3 AMBIENT STANDARDS

	State	County Code	AQCR	County Name	State	CO	NO2	Ozone
81	23	3140	123	Macomb	MI	X		X
82	23	3980	123	Oakland	MI		X	X
83	23	4780	122	Saginaw	MI	X	X	X
84	23	4620	125	St. Clair	MI		X	
85	23	5320	123	Wayne	MI	X	X	X
86	24	1480	131	Hennepin	MN	X	X	
87	24	2660	128	Olmstead	MN	X		X
88	24	2940	131	Ramsey	MN	X	X	
89	24	3260	129	St. Louis	MN	X		
90	26	1860	139	Greene	MO	X		
91	26	4280	070	St. Louis City	MO	X	X	X
92	26	4300	070	St. Louis County	MO			X
93	27	0220	141	Cascade	MT	X		
94	27	1100	144	Missoula	MT	X		
95	27	1720	140	Yellowstone	MT	X		
96	28	0780	085	Douglas	NB	X	X	
97	28	1520	145	Lancaster	NB	X		
98	29	0080	013	Clark	NV	X		
99	29	0100	148	Douglas	NV	X		
100	29	0540	148	Washoe	NV	X	X	
101	30	0140	107	Coos	NH	X		
102	30	0300	121	Hillsborough	NH		X	X
103	31	0080	150	Atlantic	NJ	X		
104	31	0660	043	Burlington	NJ	X		X
105	31	0300	045	Bergen	NJ	X		X
106	31	0740	045	Camden	NJ	X	X	X
107	31	1380	043	Essex	NJ	X	X	X

COUNTIES WITH THE POTENTIAL TO VIOLATE

CURRENT CO, NO_2, AND O_3 AMBIENT STANDARDS

	State	County Code	AQCR	County Name	State	CO	NO2	Ozone
108	31	1760	045	Gloucester	NJ	X		X
109	31	2240	043	Hudson	NJ	X	X	X
110	31	3060	043	Middlesex	NJ	X		X
111	31	3180	043	Monmouth	NJ	X		X
112	31	3260	043	Morris	NJ	X		X
113	31	3900	150	Ocean	NJ	X		
114	31	4120	043	Passaic	NJ	X		X
115	31	5020	043	Somerset	NJ	X		X
116	31	5440	043	Union	NJ	X	X	X
117	32	0140	152	Bernalillo	NM	X		X
118	32	0200	155	Chaves	NM	X		
119	32	0340	153	Dona Ana	NM	X		X
120	32	1000	014	San Juan	NM	X		
121	32	1060	157	Santa Fe	NM	X		
122	33	0600	043	Bronx	NY	X	X	X
123	33	2000	162	Erie	NY	X		X
124	33	3440	043	Kings	NY	X	X	X
125	33	4380	160	Monroe	NY			X
126	33	4520	043	Nassau	NY	X		X
127	33	4660	043	New York	NY	X	X	X
128	33	5660	043	Queens	NY	X		X
129	33	6040	161	Schenectady	NY	X		X
130	34	0480	171	Buncombe	NC		X	
131	34	1560	167	Gaston	NC		X	X
132	34	1860	171	Haywood	NC		X	
133	34	2580	167	Mecklenburg	NC	X		X
134	36	0900	079	Butler	OH		X	X
135	36	1600	174	Cuyahoga	OH	X	X	X

COUNTIES WITH THE POTENTIAL TO VIOLATE CURRENT CO, NO_2, AND O_3 AMBIENT STANDARDS

	State	County Code	AQCR	County Name	State	CO	NO2	Ozone
136	36	1640	173	Darke	OH		X	X
137	36	2220	176	Franklin	OH	X	X	X
138	36	2720	079	Hamilton	OH	X	X	X
139	36	3160	181	Jefferson	OH	X	X	
140	36	3720	124	Lucas	OH	X	X	X
141	36	3820	178	Mahoning	OH		X	X
142	36	4500	173	Montgomery	OH	X	X	X
143	36	6500	174	Summit	OH	X		X
144	36	6700	178	Trumbull	OH		X	X
145	37	2180	184	Oklahoma	OK	X		
146	37	3020	186	Tulsa	OK	X	X	X
147	38	1020	193	Lane	OR	X		X
148	38	1140	193	Marion	OR	X		X
149	38	1240	193	Multnomah	OR	X		X
150	39	0100	197	Allegheny	PA	X		X
151	39	0560	197	Beaver	PA		X	X
152	39	1300	195	Cambria	PA			X
153	39	4640	151	Lackawanna	PA		X	X
154	39	4700	196	Lancaster	PA		X	X
155	39	4940	151	Lehigh	PA		X	X
156	39	5220	151	Luzerne	PA	X		X
157	39	6580	151	Northampton	PA	X		X
158	39	7160	045	Philadelphia	PA	X	X	X
159	41	0320	120	Providence	RI	X	X	X
160	42	0560	199	Charleston	SC			X
161	42	1900	200	Richland	SC	X		X
162	44	0700	208	Davidson	TN	X	X	X

COUNTIES WITH THE POTENTIAL TO VIOLATE

CURRENT CO, NO_2, AND O_3 AMBIENT STANDARDS

	State	County Code	AQCR	County Name	State	CO	NO2	Ozone
163	44	1280	055	Hamilton	TN	X		
164	44	1720	207	Knox	TN	X	X	
165	44	3080	018	Shelby	TN	X	X	X
166	45	0420	217	Bexar	TX			X
167	45	1320	215	Dallas	TX		X	X
168	45	1710	153	El Paso	TX	X		X
169	45	2330	216	Harris	TX	X	X	X
170	45	2760	106	Jefferson	TX		X	X
171	45	5070	215	Tarrant	TX		X	X
172	45	5210	212	Travis	TX			X
173	46	0220	220	Davis	UT	X		X
174	46	0900	220	Salt Lake	UT	X	X	X
175	46	1220	220	Utah	UT	X		X
176	46	1340	220	Weber	UT	X		X
177	47	0180	159	Chittenden	VT	X		
178	48	0080	047	Alexandria	VA	X		X
179	48	0200	047	Arlington	VA	X		X
180	48	1060	047	Fairfax	VA	X		X
181	48	1440	223	Hampton	VA	X		X
182	48	2140	223	Norfolk	VA	X		X
183	48	2680	225	Richmond	VA	X	X	X
184	48	2720	226	Roanoke	VA		X	
185	49	0980	229	King	WA	X	X	X
186	49	1560	229	Pierce	WA	X		X
187	49	2060	062	Spokane	Wa	X		
188	49	2460	230	Yakima	WA			X
189	51	2220	239	Milwaukee	WI	X	X	X

References

1. AEROS, Volume II, EPA-450/2-76-029, U. S. Environmental Protection Agency, Research Triangle Park, North Carolina, 1976.

2. Mobile Source Emission Inventory Draft Report, Energy and Environmental Analysis, Inc., Arlington, Virginia, April 1980.

3. National Emissions Data System County Emissions Report, U. S. Environmental Protection Agency, Research Triangle Park, North Carolina, February 1980.

4. Modified Rollback Computer Program User's Manual, U. S. Environmental Protection Agency, Research Triangle Park, June 1979.

5. Regulatory Analysis and Environmental Impact of Final Emission Regulations for 1984 and Later Model Year Heavy Duty Engines, U. S. Environmental Protection Agency, Ann Arbor, Michigan, December 1979.

6. Mobile Source Emission Factors: Final Document, EPA-400/9-78-006, U. S. Environmental Protection Agency, Washington, D.C., March 1978.

7. Cost and Economic Impact Assessment for Alternative Levels of the National Ambient Air Quality Standards for Ozone, EPA-450/5-79-002, U. S. Environmental Protection Agency, Research Triangle Park, North Carolina, February 1979.

8. "Data Base for Air Quality Impact Assessment of Proposed Heavy-Duty Vehicle Emission Standards", Memorandum from Warren Freas, U. S. Environmental Protection Agency, Research Triangle Park, North Carolina, March 20, 1980.

9. Emission Modeling and Sensitivity Study, EPA-460/3-79-005, U. S. Environmental Protection Agency, Ann Arbor, Michigan, April 1979.