COST AND ECONOMIC IMPACT ASSESSMENT FOR ALTERNATIVE LEVELS OF THE NATIONAL AMBIENT AIR QUALITY STANDARD FOR OZONE

Economic Analysis Branch
Strategies and Air Standards Division
Office of Air Quality Planning and Standards
U.S. Environmental Protection Agency
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PREFACE

In accordance with the provisions of Sections 108 and 109 of the Clean Air Act as amended, the Environmental Protection Agency has conducted a review of the criteria upon which the existing primary and secondary photochemical oxidant standards are based. The Act specifically requires that National Ambient Air Quality Standards be based solely on scientific criteria relating to the level that should be attained to adequately protect public health and welfare. Based on the wording of the Act and its legislative history, EPA interprets the Act as excluding any consideration of the costs of achieving those standards or the existence of technology to bring about the needed reductions in emissions. However, in compliance with the requirements of Executive Orders 11821 and 11949 and OMB circular A-107 and with the provisions of the recently issued Executive Order 12044 for rulemaking proceedings which are currently pending, EPA has prepared an assessment of the potential cost and economic impacts associated with efforts to attain the proposed standard as well as alternative levels of the standard. This document presents the results of this assessment.

The purpose of the analysis contained herein is to estimate the relative ranges of national control costs for alternative levels of the ozone standard. In addition, in order to compare the relative implications of alternative standards, the range in the number of Air Quality Control Regions (AQCRs) which might be expected to attain the alternative standards given various assumptions is also indicated. Because of the many uncertainties in projecting emission levels and air quality levels and in determining effective control strategies throughout the nation, it is important to fully recognize that the results of the analysis should be viewed only as general guidance which provides an indication of relative differences in the attainment picture and the associated costs between alternative levels of the standard. The analysis cannot be used to precisely determine how many or which specific AQCRs will attain a given ozone standard through particular control strategies. Rather, attainment status and control requirements for attainment will have to be determined for each geographical area based on the unique conditions that are inherent for that area. Likewise, this analysis cannot ascertain with a great degree of precision the costs of control strategies that will be required for all areas of the country to attain alternative standards. Since the actual control costs will be extremely variable, this analysis is useful in only presenting the relative implications for costs between alternative levels of the standard.

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1.0 INTRODUCTION AND SUMMARY

The Clean Air Act, as amended in 1977, requires the Administrator of the Environmental Protection Agency to periodically review the basis of the ambient air quality standards. The National Ambient Air Quality Standard for photochemical oxidants has been reviewed and a new form of the standard has been proposed. As part of this review procedure, this report presents the results of an analysis of the potential impact of feasible changes in the standard on national costs of control and the attainment status for various areas of the country. An analysis of the potential socio-economic impact of the alternative standards has not been conducted for every affected industry and region of the country, although an assessment of the impact of control costs on selected industries is presented to give an indication of the magnitude of the impacts.

1.1 APPROACH AND METHODOLOGY

This report includes an analysis of 90 Air Quality Control Regions (AQCRs) which currently exhibit ambient ozone concentrations in excess of the current photochemical oxidant standard (.08 ppm hourly average not to be exceeded more than once per year). For each AQCR this analysis estimates potential emissions in 1987 and potential emission reductions achievable with the Federal Motor Vehicle Control Program (FMVCP), new and modified source control, application of reasonably available control technology (RACT) on existing stationary sources and further motor vehicle controls through transportation control plans. Based on the projected emission reductions, control costs are estimated for applying technology in an attempt to attain alternative standard levels. While the analysis considers each AQCR separately, the results are presented in aggregate form for all 90 AQCRs instead of each individual AQCR.

This analysis uses the 1975 emissions inventory from NEDS as the baseline emissions for each of the AQCRs. From this base 1987 emissions are projected based on statutory automotive emissions standards and reasonable ranges of assumptions for growth in vehicle miles traveled (VMT), growth in production for new sources, and retirement rates for existing sources. In addition, assumptions relating to the control of new and modified sources are made in order to determine emissions with only new source and statutory motor vehicle controls.

In order to calculate the emission reduction required, if any, for existing sources to ensure that alternative standard levels are met, the following approach is employed. For each standard level, the maximum allowable emission levels are calculated for each AQCR based on baseline ambient concentrations, 1975 emissions of non-methane hydrocarbons (NMHC), the level of the alternative standard, background ozone concentrations in urbanized areas of .02 ppm, and assumed relationships between hydrocarbon emissions and ambient ozone concentrations according to alternative modeling approaches. These two approaches are the linear rollback model and the Empirical Kinetic Modeling Approach (EKMA).

Once the allowable emissions have been calculated for each AQCR, they are compared with projected 1987 emissions levels taking motor vehicle tailpipe controls and new stationary source controls as the baseline. If additional reductions are required, available control measures are then placed on existing stationary sources that have not been replaced as well as in-use vehicle inspection/maintenance programs or VMT reduction plans for control of mobile source emissions. RACT is assumed only for those specific stationary source categories which have been identified and for which estimates of control technology and efficiencies have been made. While these sources represent the primary sources of volatile organic compounds (VOC), other sources exist, primarily small solvent evaporation sources, which have not been identified by EPA. As an extension of the analysis, reasonable levels of control for these miscellaneous solvent sources are assumed in order to determine their effect on the results of the analysis. In many instances, control of identified sources and reasonable transportation controls will not result in the required emission reductions, meaning that additional control measures will have to be applied in order to meet the alternative standards. This study does not consider additional control measures, rather only the additional emission reductions needed are indicated.

Once the control measures have been identified, the costs of the measures for the specific sources are then analyzed and estimated. The average cost per ton of emissions controlled is established for general categories of sources and combined with estimates of emission reductions achievable for the 90 AQCRs in order to obtain total annual costs of control in 1987. Costs are included for the FMVCP*, new source control, and application of RACT for identifiable sources to the extent required for each of the alternative levels of the standard. For areas that need additional control beyond the identified control measures, a rough estimate of the additional cost to attain the alternative standard is made which will reflect the magnitude of differences in total costs of the alternative levels of the standard. The costs presented in this analysis represent direct annualized costs of control which will be incurred in 1987, when it is assumed that

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*Includes costs for both HC and CO control since it is not possible to allocate costs between pollutants.

the control measures will be applied fully to the applicable sources. No estimate of total capital costs is made. In addition, there is no consideration of the secondary costs (i.e., costs beyond those encountered by the source being controlled) or benefits associated with the control measures.

1.2 LIMITATIONS OF THE ANALYSIS

In any analysis of this type many simplifying assumptions have to be made because of the uncertainties that surround the problem. The choice of assumptions, analytical tools, data bases, and approach will profoundly affect the conclusions of the analysis. This analysis attempts to place reasonable ranges on the assumptions in order to estimate the range of national costs for controls necessary to attain a given ozone level. Since the assumptions are so crucial, this section outlines the basic assumptions employed in the analysis and the limitations the choice of these assumptions place upon the results of the analysis. Because of the uncertainties, the results of this analysis are presented as ranges which serve as realistic bounds for the conclusions.

First of all, this analysis considers 90 AQCRs for which validated data on ambient concentrations exist which indicate violations of the current standard or which contain urbanized areas with populations greater than 200,000 which have been designated non-attainment by EPA. Undoubtedly, there are many other smaller urban areas as well as rural areas which currently also experience violations of the standard. However, these latter areas are not considered in the analysis since validated data have not been compiled for these areas. While this exclusion will understate the costs somewhat, it is not expected to be significant since these areas probably do not significantly exceed the standard and since the AQCRs which are considered represent well over 60 percent of the nation's population.

In order to calculate the emission reductions required in each of the AQCRs in 1987, assumptions must be made concerning the emissions inventory, baseline air quality values, growth rates, and the modeling technique to be used.

This analysis uses the preliminary 1975 emissions inventory from the NEDS Emission Summary Report, which is the only source of aggregate information on emission data for all 90 AQCRs. No attempt was made to verify the emissions inventory with data from state and local agencies, whose inventories are in some cases at variance with NEDS. Although there are some inconsistencies between NEDS and local inventories, NEDS nonetheless provides a consistent procedure for conducting the inventories throughout each AQCR and is believed to be the best available source of emissions data for national assessments.

Several reasons exist for the differences between NEDS and local inventories. First, the NEDS inventories have not yet been updated with the latest mobile source emission factors which have recently been developed by EPA's Office of Transportation and Land Use Policy. A review of these latest emission factors reveals that NEDS underestimates the mobile source emissions by 10-15 percent. Another appreciable difference between NEDS inventories and local inventories is that NEDS includes significant emission contributions from miscellaneous sources of organic solvent applications. Local inventories do not usually include the small miscellaneous sources whose emissions are relatively easy to calculate nationally based on national production statistics but are extremely difficult to calculate on a local basis. Much uncertainty exists as to the exact composition of sources in this ill-defined miscellaneous category. EPA currently has underway an extensive study to better define, classify and locate the sources of solvent evaporation.

The design ozone values used in this analysis represent only an approximation of the ambient ozone concentration that on the average will be exceeded once per year in each AQCR. These values were obtained from an analysis of air quality data for the years 1975 to 1977 using methods described in Guideline for Interpretation of Ozone Air Quality Standards (OAQPS No. 1.2-108). Analysis of air quality data indicates that this value should fall between the third and fourth highest hourly averages.

Growth rates are crucial parameters in determining the overall emission reduction which will be required in 1987. This analysis uses ranges of national average rates of growth in industrial production for various classes of industrial sources as well as ranges of national average rates of growth in vehicle miles travelled. This approach of using national growth rates simplifies the growth projections but introduces some distortions for some local areas. First of all, there is the implicit assumption that every AQCR has the same mix of sources as the nationwide mix on which the average growth rates are based. Secondly, all areas of the country will not experience the same rate of growth. For example, many highly industrialized areas with ozone problems may experience lower rates of growth than less industrialized areas which are attracting new industries. Ideally, for each AQCR, the analysis should use regional growth rates which reflect local economic conditions and the mix of sources in an area. While such an approach has not been used in this analysis, EPA is considering modifying the analysis to include regional growth rates.

Another variable in the analysis is the modeling techniques employed to estimate the allowable emissions for areas to attain alternative ozone standards. Depending on the technique used, wide variations can result in allowable emission levels and the concomitant reduction in projected emissions that is required. This analysis includes results from application of the linear rollback model as well as the Empirical Kinetic Modeling Approach (EKMA). A judgement as to which modeling approach is more valid or accurate is not made.

The emission reductions that can be achieved with application of various controls measures is still another source of variability in the analysis. The emissions inventory is segmented according to eight broad categories of industrial sources and three categories of mobile sources. Each of the stationary source categories is composed of many diverse industrial sources which are subject to varying levels of control. Thus, a weighted average control level has to be estimated for each broad category based on the assumed control levels and overall emissions for the individual source category. When this weighted average emission potential is applied to each broad category in each AQCR, it is again assumed that the mix of sources in each AQCR is the same as the nationwide mix. Thus, this assumption could well affect the results of the analysis for any AQCR.

Furthermore, RACT has not been identified or estimated with any certainty for all sources of hydrocarbons. These sources are primarily in the solvent evaporation category, where the specific sources have not been identified, control technology and efficiency have not been assessed, and whether or not these sources are amenable to control in the first place has not been determined. Without this information currently available on the remaining sources, further controls are subject to speculation. As an extension of the analysis, this analysis assumes control of these sources in order to determine their impact on control costs and attainment projections.

The approach used in defining control costs is also likely to introduce another area of variability in the analysis. For each of the many sources of VOC, the cost per ton of pollutant removed was determined based on estimated capital and operating costs for "typical" model facilities. Costs for actual facilities are likely to vary considerably, both on low and high sides, due to individual circumstances of the plants. However, the typical plant costs are considered to be representative of the industry as a whole. Once again, to aggregate the control costs for the broad categories of sources, the costs were weighted based on the nationwide mix of sources, which is not representative for all AQCRs.

The range of assumptions made in this analysis in regard to these points appear to be reasonable in terms of estimating costs of control measures for hydrocarbon control. While the intended purpose of this analysis is an estimation of the range of national costs, the approach allows the estimation of the number of AQCRs which will attain alternative levels of the standard, although this is only a secondary result which was not considered in the original design of the study. Since the approach of this study can possibly introduce more errors for an individual AQCR, the estimation of the number of AQCRs which will attain alternative standard levels is particularly sensitive to the choice of assumptions. The estimates of attainment status included in this analysis are only approximate and are valid only for the assumptions and approach used; thus, the estimates should be viewed with full recognition of the limitations of this analysis. Any choice of different assumptions or refinement of the assumptions used will naturally lead to different results. Refinement of the assumptions to a fine-tuned basis was beyond the scope of this cost study and the attainment numbers are presented only to indicate the relative differences between alternative levels of the ozone standard.

Finally, this analysis does not include a rigorous economic impact assessment on the affected industries or the impact of growth restrictions on the economies of affected urbanized areas. An analysis of the economic impact of the revised standard on the numerous industries affected is not possible to complete in the time frame available for analysis. However, EPA has conducted economic impact studies for the major emission sources, though these constitute only a portion of the total number of sources affected. Economic analyses of all affected industries are being initiated and significant results are expected within two to three years. Furthermore, the Clean Air Act does not permit the consideration of costs and economic impact in the setting of national ambient air quality standards. The incomplete character of the economic analysis for all affected sources and areas does not mitigate EPA's legal burden to propose the standard.

1.3 MAJOR FINDINGS

While the results of this analysis are sensitive to the assumptions used, several conclusions are evident which indicate the relative differences between alternative levels of the standard and the implications for control. This section summarizes the major conclusions of the analysis. Table 1-1 summarizes the results.

1.3.1 Attainment Status for Major AQCRs

Many areas of the country will not be able to attain a .08 ppm level based on the statistical form of the standard by 1987. Based on the results from the linear rollback model, anywhere from one-third to two-thirds of the major AQCRs in the country will require stationary control measures beyond NSPS and RACT as well as additional transportation control measures in order to approach the standard. For a .10

Table 1-1. SUMMARY OF ESTIMATED CONTROL COSTS AND ATTAINMENT STATUS IN 1987 FOR VARIOUS LEVELS OF THE OZONE STANDARD

Level of Standard	Modeling Technique	Number of AQCRs Attaining Standard with Identified Control Measures[a,b]	Range of Costs for Identified Measures[a,b,e] ($ Billions)	Range of Estimated Costs of Attainment[a,c] ($ Billions)
.08 ppm	Linear Rollback	25-60	$4.5-6.0	$6.0-8.0
.10 ppm		60-80	$4.3-5.6	$5.0-6.5
.12 ppm		75-85	$4.1-5.2	$4.5-5.5
.14 ppm		81-88	$4.0-4.9	$4.0-5.0
.08 ppm	EKMA	3-4	$4.6-6.2	$9.0-12.5
.10 ppm		17-43	$4.5-6.1	$7.0-9.0
.12 ppm		49-74	$4.3-5.7	$5.5-7.0
.14 ppm		63-80	$4.2-5.5	$5.0-6.5

[a] Ranges due to range of assumptions in growth rates, degree of control achievable with RACT, and unit costs.

[b] Identified control measures are FMVCP, NSPS, I/M, limited TCP's, and two levels of RACT.

[c] Costs are annual control costs in 1987, taking into account net operating and maintenance costs as well as annualized capital charges.

[d] Control measures for total attainment have not been identified. The estimated costs represent the additional emission reduction required multiplied by a lower-bounds cost estimate of $1000 to $1500 per ton controlled.

standard level, all but 10 to 30 AQCRs may achieve the standard by 1987 with the control measures identified in this analysis. The lower estimate reflects a low growth scenario with extensive RACT measures placed on all significant stationary source categories, including the solvent evaporation source categories which have yet to be assessed in detail to determine their amenability to control. On the other hand, the higher estimate is based on a higher growth scenario without control of those solvent evaporation categories which have not been assessed. Finally, at a .12 standard level, all but five AQCRs could attain the standard under the low growth/high control scenario, while all but 13 could attain under the less optimistic case.

The application of EKMA in the analysis does not lead to as optimistic results since EKMA, with the assumptions used in this analysis, tends to require significantly more control than rollback. The results from EKMA could vary appreciably for any urbanized area depending primarily upon the ratio of ambient non-methane hydrocarbons to nitrogen oxides. Thus, the results from EKMA would be more accurate if NMHC/NOx ratios were available for every AQCR. Based on a typical nationwide ratio of 9.5:1, EKMA predicts that only three or four AQCRs could attain a .08 ppm standard by 1987. Even at .10 ppm, less than half of the AQCRs could attain the standard even assuming low growth and high control, while at .12 ppm more than 15 AQCRS would still be in violation in 1987 without applying further controls.

1.3.2 Implications for Further Control

This analysis confirms that most areas of the country will have to apply extensive control measures in order to attain any of the reasonable levels of the standard. Areas will have to place controls on new and modified sources, aggresively apply RACT to existing sources, institute effective inspection/maintenance programs for in-use vehicles, and implement various degrees of measures to reduce vehicle miles traveled in the urbanized areas. While higher levels of the standard will mean that some areas will come into attainment automatically or will require less emission reduction, most major urbanized areas will not be able to relax control efforts. Because ozone is such a pervasive and intense air pollution problem, any modest relaxation of the standard will not result in any significant changes to existing or planned control strategies for these areas. The major urban areas will need to continue applying all available control measures.

The results of this analysis also indicate the need for the identification of miscellaneous solvent uses as well as miscellaneous industrial processes and the assessment of the applicability of control measures for these sources. Current data indicate that these sources represent a significant source of emissions which will need to be controlled if many areas are to attain the alternative levels of the standard. For instance, at a .08 ppm level, control of these sources would result in an additional 25 percent of the 90 AQCRs attaining the standard under the low growth scenario using linear rollback.

1.3.3 Costs of Control

As Table 1-1 indicates, the annual cost in 1987 of applying reasonable, identified control measures will range from $4.0 to $6.0 billion for all levels of the standard under consideration. The cost difference between alternative standards is not as great as might be expected for two basic reasons. First, the vast majority of the total annual costs ($3.7 to $4.3 billion) result from the FMVCP and new source controls, which are assumed to be the same regardless of the level of the standard. Secondly, the RACT control costs do not differ greatly from alternative standards since many areas will have to apply full RACT regardless of the level of the standard.

Since many AQCRs will not attain alternative levels of the standard by applying the reasonably available control measures considered in this analysis, additional control measures will be needed in some areas in order to reduce emissions even further so that the standards can be attained. These measures could include restrictive transportation control measures that significantly reduce vehicle miles traveled in urban areas, control of stationary sources for which RACT has not been identified or defined, tighter controls on new and existing sources other than those achievable with RACT and restrictions on growth. While the costs of such measures have not been estimated, on the whole they are believed to be more costly than current measures. Even though the costs are not precisely known, it is still useful to estimate the cost of attainment in some manner in order to better indicate the cost differences between alternative standards. To do this, a cost estimate of $1,000 to

$1,500 per ton of emissions controlled is assumed for the additional emissions reductions required for each AQCR to attain the alternative standards. Table 1-1 summarizes the estimated costs of total attainment for the alternative standards. The cost differential between standard levels is greater, with the 1987 annual costs for the alternative standards under consideration ranging from $4.0 to $8.0 billion using the results from the linear rollback model. Based on the results from EKMA, total attainment for a .08 ppm standard could result in annual costs ranging from $9.0 to $12.5 billion.

2.0 BASELINE AIR QUALITY AND ALLOWABLE EMISSION LEVELS

This section examines the current ambient levels of air quality in non-attainment areas in order to establish a basis for determining the levels of emission control required to meet alternative levels of the ozone standard. Based on these air quality levels, techniques for establishing allowable emission levels in individual areas are discussed.

2.1 EXISTING AMBIENT AIR QUALITY LEVELS

Many areas of the country are experiencing levels of ozone and oxidant concentrations well above the present standard. In this analysis 90 Air Quality Control Regions (AQCRs) are considered which have validated data that indicate ambient concentrations at or above the present standard of .08 ppm. While other areas of the country may currently violate the standard, validated data were not available for additional AQCRs. Nonetheless, the AQCRs considered contain all the major urbanized areas with populations greater than 200,000.

The baseline ozone design values for the 90 AQCRs are based upon a listing contained in Appendix A.[1] These values reflect an approximation of the ambient concentration that on the average will be exceeded once per year in each AQCR. Using analytical methods for the statistical form of the ozone NAAQS, these values were obtained from an analysis of data for the years 1975 to 1977.[2] Using three years of data the design value would be expected to fall between the third and fourth highest hourly averages. In selecting the design values, the fourth highest hourly average over a three year period was used, unless the difference between the third and fourth highest values exceeded .01 ppm, in which case the third and fourth highest values were averaged.

Figure 2-1 shows the distribution of the design air quality values among the 90 AQCRs for which there are data. About 46 percent of the areas are above twice the level of the present standard and about nine percent are three times above the standard. The adoption of alternative levels of the standard in the range of .08 ppm to .14 ppm would have an immediate effect of bringing six to 32 of the AQCRs into compliance, depending on the level of the standard.

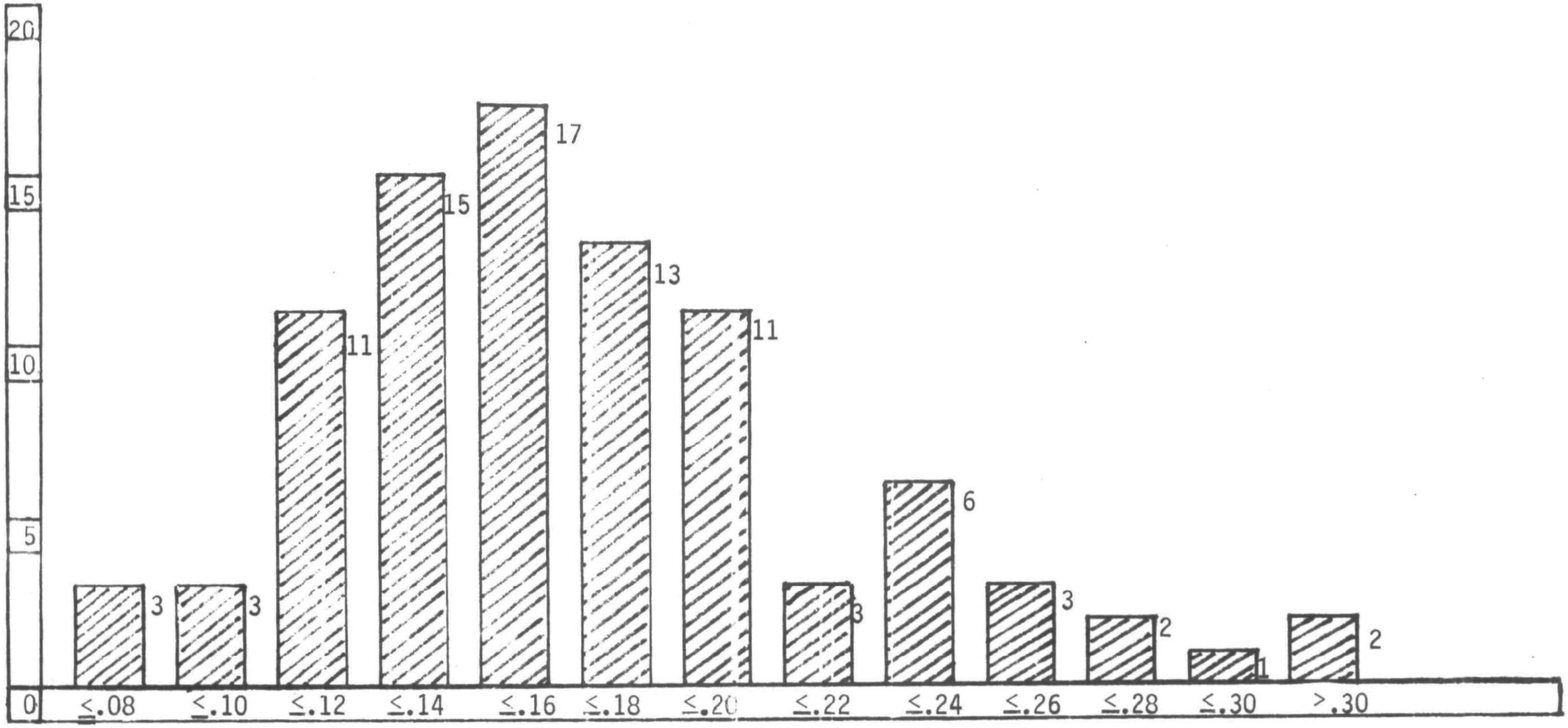
2.2 ALLOWABLE EMISSION LEVELS

For each alternative level of the standard, the maximum allowable emission levels are calculated for each AQCR based on baseline air quality levels discussed earlier, 1975 total emissions of non-methane hydrocarbons (NMHC), the level of the alternative standard, background ozone levels of .02 ppm and assumed relationships between hydrocarbon emissions and ambient ozone concentrations. The maximum allowable emission levels indicate, based on the parameters listed, the emissions which will permit attainment and maintenance of the standard. The 1975 emission levels for each AQCR were obtained from the NEDS Emission Summary Report (NE204), corrected to exclude methane.

Two modeling approaches were used to estimate the allowable emission levels. The first is the linear rollback model which assumes a proportional relationship between hydrocarbon emissions and ambient ozone concentrations, with appropriate adjustment for natural background levels of ozone. The relationship is given by the following equation:

$$\frac{\text{Allowable emissions}}{\text{Current emissions}} = \frac{\text{(Standard level minus background)}}{\text{(Current ambient concentration minus background}}$$

Figure 2-1. Frequency Distribution of Design Values for 90 Non-Attainment AQCRs[a]



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[a] Based on Appendix A.

The alternative approach is the Empirical Kinetic Modeling Approach (EKMA), which employs isopleths based on the results of smog chamber experiments to relate various concentrations of NMHC and nitrogen oxides (NOx) to resulting concentrations of ozone. In employing the model it is necessary to make assumptions as to:

1. the prevailing 6-9 a.m. ratio of ambient NMHC to NOx.
2. the relative degree to which NMHC and NOx emissions will be controlled, and
3. ozone background levels.

While the NMHC/NOx ratios for various cities will vary widely, it is beyond the scope of this analysis to determine the appropriate ratios for every city. However, best estimates of typical 6-9 a.m. ratios, based on an examination of data from a number of monitoring sites, indicate a median ratio of 9.5:1, which is used in EKMA for purposes of this analysis. In addition, it is assumed that NOx emissions remain constant between 1975 and 1987.

A background level of .02 ppm ozone in urban areas is added in both modeling approaches. While measurements conducted in remote locations suggest that natural background ozone is about .04 ppm, simulation results indicate that the impact of natural ozone on peak hourly ozone concentrations in urban areas ranges from .01 to .03 ppm, with .02 ppm being most likely.[3]

This analysis presents the results from both modeling techniques since both are considered viable approaches for relating ambient ozone to organic compounds and oxides of nitrogen. No judgement is made as to the relative effectiveness or accuracy of the alternative approaches. For a full discussion of the technical basis, uses and limitations of the approaches, consult reference 2.

In essence, EKMA is a rather complex model that has been primarily validated against data from smog chambers, which represent a simplification of the urban atmosphere. In addition, the absolute positions of the standard isopleths represent an approximation since their position depends upon a number of underlying assumptions concerning meteorological conditions and emission patterns.[3]

Rollback, on the other hand, is a rather simple approach that contains the assumptions that ozone concentrations are proportional to NMHC emissions and that the amount of organic emission controls needed to attain ambient ozone levels is independent of the prevailing NMHC/NOx ratio. However, smog chamber experiments suggest that the lower the ratio, the more effective the hydrocarbon reduction is in reducing the maximum ozone formed. Thus, at very low NMHC/NOx ratios, linear rollback may underestimate the effectiveness of organic controls, while at high ratios estimates may be overly optimistic. Nonetheless, under the range of NMHC/NOx ratios believed to prevail in most U.S. cities, rollback appears to be useful in serving as a lower bound for estimates of hydrocarbon controls needed to attain the ozone standard.[3]

Application of the two modeling approaches gives somewhat different results. Table 2-1 illustrates the comparative control levels required for alternative standard levels utilizing both approaches.[4] With the exception of cases having very low NMHC/NOx ratios, needed NMHC reductions estimated with rollback are almost always less than those obtained with the standard isopleth version of EKMA.

Table 2-1. PERCENT HC REDUCTIONS REQUIRED TO MEET VARIOUS LEVELS OF THE STANDARD GIVEN SECOND MAXIMUM OZONE CONCENTRATIONS[2]

Ozone Design Value (Second Maximum Hourly Ozone Concentration)

Ozone Design Value STD	.10	.14	.18	.22	.26	.30	.32	.34	.36	.38
.06	69 50	80 67	80 75	81 80	81 83	81 86	81 87	81 88	81 88	81 89
.08	44 25	67 50	72 63	75 70	77 75	78 79	78 80	78 81	78 82	79 83
10	0 0	57 33	67 50	70 60	73 67	74 71	75 73	75 75	76 76	77 78
12	0 0	30 17	57 38	66 50	69 58	71 64	72 67	72 69	74 71	74 72
15	0 0	0 0	35 19	55 35	64 46	68 54	68 57	69 59	70 62	71 64

EKMA Assumptions:
(1) Impact of natural background ozone concentrations on maximum afternoon ozone levels = .02 ppm ozone.
(2) No transport from upwind cities
(3) Default NMHC/NOx Ratio = 9.5:1.
(4) No NOx Control

EKMA
Rollback

Rollback:

$$\%HC = \left[\frac{O_3 - STD}{O_3 - BKG}\right] \cdot 100$$

Using both modeling approaches, allowable emission levels were calculated for each AQCR. These levels were then compared to projected 1987 baseline emission levels in order to determine the emission reduction that needs to be effected so that all areas will attain the standard level by 1987. These emission projections and control requirements are discussed in the next section.

2.3 REFERENCES FOR CHAPTER 2

1. Neligan, Robert E., Monitoring and Data Analysis Division (MDAD), OAQPS, EPA, memorandum to Bruce Jordan entitled "Ozone Design Values for 90 Air Quality Control Regions," May 24, 1978.

2. Environmental Protection Agency, Guideline for Interpretation of Ozone Air Quality Standards, OAQPS No. 1.2-108, Draft.

3. Environmental Protection Agency, Uses, Limitations and Technical Basis of Procedures for Quantifying Relationships Between Photochemical Oxidants and Precursors, EPA-450/2-77-021a, November 1977.

4. Freas, Warren P., MDAD, memorandum to Edward J. Lillis entitled "Estimates of HC Reductions Required to Meet Selected Ozone Levels Given Second Maximum Ozone Concentrations." December 4, 1977.

3.0 PROJECTION OF EMISSIONS IN 1987 AND REASONABLE LEVELS OF CONTROL ACHIEVABLE

This chapter summarizes the emission projections and emission reductions achievable by 1987 for the affected AQCRs. Reasonable ranges of growth rates are applied to 1975 emissions in order to determine 1987 baseline emissions without additional stationary source and mobile source controls other than mobile source standards mandated by the Clean Air Act. Stationary source controls in the form of new source standards and reasonably available control technology (RACT) for existing sources as well as additional mobile source controls in the form of inspection/maintenance programs and transportation control measures are assessed and potential emission reductions quantified. These projected emission reductions are then compared with the baseline 1987 emissions and the calculated maximum allowable emission levels to determine if the available controls result in attainment of the alternative levels of the standards. If the standards are not attained, the additional emission reduction required to reach the allowable emission levels is indicated.

For purposes of this study, RACT is broadly defined as technology readily available for application in categories of sources which will lead to adequate levels of control based solely on technical considerations. Because of unique circumstances with individual sources, the reasonableness of technology for particular sources will be determined by state and local agencies based on technical guidance issued by EPA and depending upon economic and energy feasibility.

Emission reductions due to new and modified source controls are applied to the growth in new stationary source emissions over the time period in addition to the emissions from the replacement of existing sources with new or modified sources. This analysis uses a reasonable range of national growth rates which will bound the extreme variability in stationary source growth throughout regions of the country.

Projections are made for each individual AQCR based on its emission inventory and national estimates of growth rates and control efficiency. National totals of baseline emissions and emission reductions are obtained by summing the totals for the individual AQCRs.

The assumptions and methodology used in this analysis were chosen specifically to arrive at national emission and cost estimates. For planning in any specific AQCR, more detailed analyses will be required. The procedures to be followed for preparing detailed plans are presented in the document, "Control Strategy Preparation Manual for Photochemical Oxidants."[1]

3.1 MOTOR VEHICLE EMISSIONS IN 1987

Mobile sources include light-duty vehicles, other highway vehicles, and non-highway vehicles (such as aircraft, barges and vessels, railroads and earth moving equipment). The Federal Motor Vehicle Control Program (FMVCP) for highway vehicles will significantly reduce emissions from these sources. This reduction is counterbalanced by an estimated two to three percent growth per annum in total miles traveled for most areas of the country.[2] For light-duty vehicles, a total reduction of emissions of 60 to 66 percent is projected by 1987 taking into account both growth and tailpipe controls.

(See Appendix B). Similar reductions for other highway vehicles are expected to be 30 to 40 percent through the FMVCP. These factors are included in the estimated baseline emission projections for 1987 in Table 3-1.

Even though the FMVCP will reduce mobile source emissions by 50 to 60 percent, this will not be adequate to offset the growth of stationary source emissions for most areas. Only in the unique circumstance where an area with a high proportion of mobile source emissions is close to the standard will the FMVCP alone permit attainment of the standard. For a .08 ppm standard level, this will pertain to only one or two AQCRs, while up to eight AQCRs could be affected with a .10 ppm standard level.[3]

3.2 UNCONTROLLED EMISSIONS FROM STATIONARY SOURCES

In order to determine the total reduction in emissions required in 1987 for each AQCR to achieve the allowable emission level, growth in the emissions inventory has to be taken into account. In Table 3-1, uncontrolled emissions in 1987 are projected for eight stationary source categories in addition to the three mobile source categories. These projections include the existing emission inventory as well as the growth of new sources. For each of the eight stationary source categories, as segmented in the NEDS Emission Summary Report, a range of representative growth rates has been determined and applied to the existing emission inventory in order to determine the uncontrolled emission levels in 1987. Table 3-2 summarizes the range of growth rates used in this analysis for each source category.[4]

Table 3-1. PROJECTED NON-METHANE HYDROCARBON (NMHC) EMISSIONS IN 1987 FOR 90 NON-ATTAINMENT AQCRs.[1]
(Millions of tons per year)

Source Category	1975 Emissions[a]	1987 Emissions With FMVCP & No Stationary Source Control	1987 Emissions With FMVCP & New Source Control
Light-duty vehicles	5.30	1.80-2.06	1.80-2.06
Other highway vehicles	0.96	0.58-0.65	0.58-0.65
Non-highway vehicles	1.04	0.69-0.78	0.69-0.78
Oil and gasoline marketing[b]	0.79	1.00-1.13	1.00-1.13
Fuel Combustion	0.13	0.15-0.17	0.15-0.17
Chemical manufacturing	0.43	0.69-0.87	0.40-0.43
Petroleum Industries	0.43	0.53-0.61	0.27-0.28
Other Industrial Processes	0.53	0.75-0.84	0.75-0.84
Solvent and Petroleum Evaporation[c]	8.67	12.38-15.60	7.19-7.80
Solid Waste	0.24	0.19	0.19
Miscellaneous	0.07	0.07	0.07
TOTAL	18.59	18.84-22.97	13.09-14.40

[a] This emissions inventory represents the sum of emissions for each AQCR obtained from the NEDS Emission Summary Report (NE204)

[b] Includes only service stations.

[c] Includes emissions from gasoline bulk terminals, bulk plants, and gasoline and crude oil storage in addition to solvent application sources. This categorization is from the NEDS Emissions Summary Report, which is currently being revised to more appropriately segment sources.

Table 3-2. RANGE OF GROWTH RATES FOR MOBILE AND STATIONARY SOURCES[4]
(Compounded Percent per Year)

	LOW	HIGH
Mobile Sources(VMT	2	3
Oil and Gas Marketing	2	3
Fuel Combustion	1	2
Chemical Manufacturing	4	6
Petroleum Industries	2	3
Other Industrial Processes	3	4
Solvent and Petroleum Evaporation	3	5
Solid Waste	-2	-2
Miscellaneous	0	0

Baseline emissions from oil and gas marketing, which in NEDS includes only service stations, are a function of the growth in vehicle miles traveled, which is estimated to grow at a rate of two to three percent per year. This growth is tempered somewhat by a projected 10 percent improvement in fuel economy. While new vehicles in the mid-1980's are expected to be 20 to 25 percent more efficient than 1975 vehicles, this 10 percent efficiency factor represents an average of the entire vehicle fleet over time.

Emissions from fuel combustion are expected to grow at a rate of approximately one to two percent per year. The major industrial process sources of HC, chemical manufacturing and petroleum refining, are estimated to grow at annual rates of four to six and two to three percent, respectively. Other industrial processes are expected to grow at three to four percent per year.

Solvent and petroleum evaporation is by far the largest source of emissions, constituting 47 percent of the total hydrocarbon emissions and 77 percent of the stationary source emissions in the 90 non-attainment AQCRs. In NEDS, this category includes a variety of sources such as industrial surface coatings, adhesive applications, dry cleaning, asphalt application, graphic arts, metal cleaning and degreasing, gasoline bulk terminals and bulk plants, crude oil storage, and many other small individual sources, such as architectural coatings.* Growth in these many sources is expected to vary widely and thus growth of emissions

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*The NEDS Emissions Summary Report is currently undergoing revision so as to more appropriately segment common sources. Nonetheless, this report utilizes the existing NEDS categorization since NEDS is the only source AQCR emission inventories.

could be extremely variable in individual AQCRs depending on the mix of sources. Nonetheless, an overall growth rate range of three to five percent is predicted for all the sources if recent solvent use levels continue. However, this growth could be less than projected because of increased costs of solvents and the use of high solids coatings or water-based coatings. Assuming a growth rate of five percent in emissions, by 1987 the solvent and petroleum evaporation category will constitute 68 percent of the total hydrocarbon emissions and 81 percent of the stationary source emissions in the 90 AQCRs.

3.3 EMISSION PROJECTIONS WITH CONTROLS ON NEW STATIONARY SOURCES

In non-attainment areas of the country, the recent Clean Air Act Amendments require new and modified stationary sources to achieve the lowest achievable emission reduction (LAER) before the source can be located in an area or modified. Hence, this requirement will result in a significant reduction in emissions from new and modified stationary sources. In order to estimate the reduction in uncontrolled emissions that can be achieved, assumptions as to the efficiency of new source controls have to be made. Since EPA has not yet determined what constitutes LAER for stationary sources, this analysis assumes that new and modified sources will have to achieve a minimum level of control equal to RACT. The underlying assumptions in the determination of RACT control levels will be discussed in the next chapter. The assumed new source control level for applicable sources are summarized below:

• Chemical Manufacturing	82%
• Petroleum Industries	96%
• Solvent and Petroleum Evaporation	81%

No new source controls are assumed for the other stationary source categories since achievable control levels with RACT have not been identified. In the case of service stations, no new source controls are included since relatively few new service stations are anticipated to be built in the near future due to the significant attrition of stations currently underway.[5]

Table 3-1 summarizes the baseline emissions in 1987 assuming statutory motor vehicle controls and minimum controls on new and modified stationary sources. These stationary source estimates include the normal replacement of existing sources (due to obsolescence) with new, modified, or reconstructed sources that would be subject to control under LAER. As shown in the table, even with growth in emission sources, new source controls on new and modified sources in conjunction with motor vehicle controls will result in an aggregate 20 to 30 percent reduction in hydrocarbon emission levels in the 90 AQCRs by 1987.

3.4 REASONABLY AVAILABLE CONTROL MEASURES FOR EXISTING SOURCES

3.4.1 Estimates of RACT for Stationary Source Categories

For areas that fail to attain the standard with mobile source and new and modified source control, existing sources will be required to install reasonably available control technology (RACT) in order to attempt to attain the standard. RACT will vary among industries and may well vary among sources within an industry. RACT is defined as the lowest emission limit that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility. Since economic feasibility is basically source specific, RACT may vary among sources in an industry. Since this study considers broad categories of sources and does not consider the feasibility of RACT on individual sources, RACT is broadly defined for purposes of this study as technology available for application in categories of sources which will lead to adequate levels of control based solely on technical considerations. In actual practice, the reasonableness of technology for particular sources will be determined by state and local agencies based on technical guidance issued by EPA and depending upon economic and energy feasibility.

EPA is currently developing guideline documents for sources of VOC which will assess the technology available for these sources. Based on studies underway in support of these documents, estimates have been made as to the efficiency of RACT for many industries which constitute major sources of VOC.[6] The industries and individual emission sources are summarized in Table 3-3, which also presents the estimated efficiency of RACT for these sources.

While these sources represent the primary sources of VOC, other sources exist which have not been studied by EPA. These sources are primarily in the solvent evaporation category. In many cases, the

Table 3-3. ASSUMED EFFICIENCY OF RACT FOR STATIONARY SOURCE CATEGORIES[6,7]

Source Category and Sources Included[a]	Efficiency of RACT (%)
1. Chemical Manufacturing	
• Organic Chemical Manufacturing Industry	
- Process Emissions	90%
- Fugitive Emissions	80%
- Storage and Loading Emissions	90%
- Secondary Emissions	75%
• Pharmaceutical Industry	95%
• Paint Manufacture	90%
• Rubber Industry	75%
Weighted Average of RACT[b]	82%
Current Emissions Affected by RACT[c]	79%
Emission Reduction in Source Category Achievable with RACT	65%
2. Petroleum Industry	
• Gas and Crude Oil Production	90%
• Petroleum Refining	
- Vacuum Jets	100%
- Waste Water Separators	95%
- Miscellaneous Sources	91%
- Process Unit Turnaround	98%
• Natural Gas and Gasoline Plants	96%
Weighted Average of RACT[b]	96%
Current Emissons Affected by RACT[c]	96%
Emission Reduction in Source Category Achievable with RACT	92%
3. Solvent and Petroleum Evaporation	
Auto and Light Duty Truck Manufacturing	80%
Graphic Arts	80%
Flatwood Products	80%
Paper Coating	81%
Fabric Coating	81%
Shoe Adhesive	81%
Wire Coating	90%
Packing Laminates	81%
Can Coating	80%
Metal Furniture	85%
Industrial Machinery	80%
Commercial Machinery	80%
Coil Coating	85%
Fabricated Metal Products	80%

Table 3-3. (continued)

Source Category and Sources Included[a]	Efficiency of RACT (%)
Large Appliances	85%
Small Appliances	80%
Dry Cleaning	65%
Cutback Asphalt Paving	100%
Cold Cleaning	50%
Vapor Degreasing	55%
Gasoline Bulk Plants	90%
Gasoline Bulk Terminals	90%
Gasoline and Crude Oil Storage	75%
Weighted Average of RACT[b]	81%
Current Emissions Affected by RACT[c]	48%
Emission Reduction in Source Category Achievable with RACT	39%
4. Oil and Gasoline Marketing	
Service Stations-Storage	90%
Service Stations-Refueling	90%
Weighted Average of RACT[b]	90%
Current Emissions Affected by RACT[c]	99%
Emission Reduction in Source Category Achievable with RACT	89%
5. Fuel Combustion[d]	0%
6. Other Industrial Processes[d]	0%
7. Solid Waste[d]	0%
8. Miscellaneous[d]	0%

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[a] Sources included are those for which screening studies or guideline documents are being prepared. Many solvent evaporation sources and other industrial processes are not included because the sources have not been identified or control levels have not been defined.

[b] Represents weighted average of RACT for sources listed based on current national emissions for each category.

[c] Represents the proportion of current national emissions for which RACT can be applied. Excludes emissions from source categories for which RACT control levels have not been identified (based on reference 6) and the residual emissions from sources which have already controlled to the RACT level

[d] RACT has not been identified for these source categories.

specific sources have not been identified and control technology and efficiency have not been assessed, though these sources will be analyzed in detail in the future.

Since the emission inventory for each AQCR from NEDS is segmented according to the eight broad source categories, the average emission reduction that could be achieved with the application of identified RACT has to be determined for the categories. To do this, it is first necessary to derive the weighted average of the efficiency of RACT for the sources in each category for which RACT has been estimated. This weighted average takes into account the relative contribution to current national emissions and the efficiency of RACT for each source.[6] After this calculation, the total emission reduction in each general source category is determined by multiplying the weighted efficiency of RACT for applicable sources by the percentage of emissions in the general source category which would be affected by RACT. The emissions affected by RACT include only those sources for which RACT has been identified and which have not already controlled emissions to the RACT level. Thus, this excludes sources not covered by RACT and those already controlled since these latter sources already achieve RACT control.[6,7]

As Table 3-3 indicates, emissions from existing sources can be reduced by 65 percent from the chemical manufacturing industry, 92 percent from the petroleum industry, and 89 percent from oil and gas marketing. However, controls on identified solvent and petroleum evaporation sources will reduce emissions from the total category by only 39 percent, since over half of the emission inventory results from sources which have not been identified and for which control levels have not been estimated. While the control of identified sources serves as the basis for this analysis, a sensitivity analysis is included which assumes a moderate level of control on the emissions from the unidentified solvent sources. This assumed level of control is 65 percent of all solvent evaporation emissions. Through the remainder of the document, the control of identified sources only is termed "identified" RACT while the assumed control of the entire solvent evaporation category is termed "advanced" RACT.

3.4.2 Estimates of RACT for Mobile Source Categories

There are measures in addition to tailpipe standards which are available to reduce emissions from mobile sources. Reasonably available measures for mobile vehicles include inspection/maintenance as well as traffic reduction measures such as transit improvements, parking management, and traffic management. The emission reduction potential for each of these measures will vary among areas dependent on the applicability of control measures, the relative contribution of each mobile source category, existing traffic patterns, and other factors.

In this study, it is anticipated that an inspection/maintenance program for light-duty vehicles could achieve a reduction of up to 30 percent of 1987 emissions from the LDV category, with the FMVCP as baseline, though the effectiveness could range from 20 to 50 percent.[8,9] In addition, for purposes of this study, traffic reduction plans are estimated to reduce vehicle miles traveled by 10 percent compared to the projected baseline in 1987. Hence, total RACT for light duty vehicles is estimated to represent a 37 percent reduction. Similarly, the emissions from other highway vehicles can be reduced an additional five percent through traffic reduction.

3.4.3 Total Emission Reductions with RACT

Table 3-4 summarizes the total emission reduction in the 90 nonattainment AQCRs that can be achieved by applying both identified and advanced RACT to existing sources that will not be replaced before 1987. Baseline emissions in 1987, taking into account FMVCP and controls on new and modified sources, can be reduced by an additional 30 to 35 percent with the application of RACT. Of course, the reduction in individual AQCRs will vary depending on the mix of sources in the area.

This reduction with RACT does not take into account the control of replaced sources that would also be controlled to the LAER level (see Section 3.3). Considering the control of replaced sources, existing stationary source emissions can be reduced from 1975 to 1987 by an average of 52 percent with identified RACT and 66 percent with advanced RACT.

3.5 ATTAINMENT STATUS AND ADDITIONAL REDUCTION REQUIRED

Even with full application of RACT to identified source categories, many AQCRs will not be able to attain alternative levels of the standard. Tables 3-5 and 3-6 summarize the attainment status for the AQCRs for the alternative standard levels. Using the linear rollback model (Table 3-5), from 30 to 60 AQCRs will attain a standard level of .08 ppm depending on the assumptions as to growth rates and the control levels achievable. As the table indicates, as the standard level increases more AQCRs will naturally come into attainment, to the point that all but two to nine

Table 3-4. TOTAL EMISSION REDUCTION ACHIEVABLE IN 1987 WITH FULL APPLICATION OF RACT TO IDENTIFIED SOURCES FOR 90 NON-ATTAINMENT AQCRs (millions of tons per year)

	1987 Emissions with FMVCP and Control of New and Modified Sources	Identified RACT		Advanced RACT	
		Emission Reduction with RACT	1987 Emissions with Total Control Achievable	Emission Reduction with RACT	1987 Emissions with Total Control Achievable
Light Duty Vehicles	1.80-2.06	0.66-0.76	1.14-1.30	0.66-0.76	1.14-1.30
Other Highway Vehicles	0.58-0.65	0.03	0.55-0.62	0.03	0.55-0 62
n-highway vehicles	0.69-0.78	0	0.69-0.78	0	0.69-0.78
l and Gasoline Marketing	1.00-1.13	0.88-1.00	0.12-0.13	0.88-1.00	0.12-0.13
Fuel Combustion	0.15-0.17	0	0.15-0.17	0	0.15-0.17
Chemical Manufacturing	0.40-0.43	0.22	0.18-0.21	0.22	0.18-0.21
Petroleum Industries	0.27-0.28	0.24	0.03-0.04	0.24	0.03-0.04
Other Industrial Processes	0.75-0.84	0	0.75-0.84	0	0.75-0.84
lvent and Petroleum Evaporation	7.19-7.80	2.32	4.87-5.48	3.91	3.28-3.89
Solid Waste	0.19	0	0.19	0	0.19
Miscellaneous	0.07	0	0.07	0	0.07
TOTAL	13.09-14.40	4.35-4.57	8.74-9.83	5.94-6.16	7.15-8.24

Table 3-5. ATTAINMENT STATUS AND ADDITIONAL EMISSION REDUCTION REQUIRED FOR 90 AQCRs UNDER ALTERNATIVE OZONE STANDARDS (ROLLBACK)

Level of Standard (ppm)	Allowable Emissions 1987 (10^6 Tons)	Approximate No. of AQCRs Attaining Standard[a]			Additional Emission Reductions Needed[b] (10^6 Tons)		
.08	6.7	60	38	25	1.2	2.3	3.2
.10	8.7	80	68	60	0.5	1.2	1.8
.12	10.2	85	81	75	0.2	0.6	1.0
.14	11.3	88	84	81	0.1	0.2	0.5
Assumptions:							
Background	.02	.02	.02	.02	.02	.02	.02
Growth Rates	--	Low	Low	High	Low	Low	High
RACT	--	Advanced	Identified	Identified	Advanced	Identified	Identified

[a] This is only an approximate number based on assumptions outlined in this report.

[b] The total reduction in emissions estimated to be needed for all 90 AQCRs to attain the alternative levels of the standard.

Table 3-6. ATTAINMENT STATUS AND ADDITIONAL EMISSION REDUCTION REQUIRED FOR 90 AQCRs UNDER ALTERNATIVE OZONE STANDARDS (EKMA)

Level of Standard (ppm)	Allowable Emissions 1987 (10^6 Tons)	Approximate Number of AQCRs Attaining Standard[a]			Additional Emission Reductions Needed[b] (10^6 Tons)		
.08	3.1	4	3	3	4.1	5.6	6.7
.10	5.8	43	26	17	1.8	3.1	4.1
.12	8.1	74	62	49	0.8	1.6	2.3
.14	9.1	80	71	63	0.5	1.1	1.7
Assumptions:							
Background	.02	.02	.02	.02	.02	.02	.02
Growth Rates	--	Low	Low	High	Low	Low	High
RACT	--	Advanced	Identified	Identified	Advanced	Identified	Identifie

[a] This is only an approximate number based on assumptions outlined in this report.

[b] The total reduction in emissions estimated to be needed for all 90 AQCRs to attain the alternative levels of the standard.

AQCRs could attain a .14 standard level by 1987. The use of EKMA, on the other hand, leads to more pessimistic results (Table 3-6). According to this modeling approach, only three to four AQCRs could attain a .08 standard by 1987, while at most 80 AQCRs could attain a .14 standard level. These attainment numbers are only approximate and could vary significantly depending on assumptions for each AQCR pertaining to design air quality values, growth rates, control levels, emissions inventory, and the modeling technique employed.

Tables 3-5 and 3-6 also indicate the total additional emission reductions estimated to be needed for all 90 AQCRs to attain the alternative levels of the standard. For comparison purposes, the allowable emission levels are also presented.

3.6 REFERENCES FOR CHAPTER 3.0

1. Environmental Protection Agency, *Control Strategy Preparation Manual for Photochemical Oxidants*, OAQPS Guideline Series No. 1.2-047, January 1977.
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9. Environmental Protection Agency, *Appendix N to 40 CFR Part 51: Emission Reductions Achievable Through Inspection and Maintenance of Light Duty Vehicles, Motorcycles, and Light and Heavy Duty Trucks*, May 1977.

4.0 NATIONAL COSTS OF CONTROL FOR ALTERNATIVE LEVELS OF THE STANDARD

In the previous sections of this report, estimates were made of the amount of non-methane hydrocarbon control needed to meet alternative levels of the ozone standard and control levels achievable with available control measures. A comparison will now be made between alternative levels in terms of the cost of applying available controls for various mobile and stationary sources. The average cost per ton of emissions controlled will be established for general categories of sources and combined with estimates of emission reductions achievable in order to obtain total costs of control. The costs presented represent the costs incurred in the 90 non-attainment AQCRs under consideration in the previous section.

The costs presented in this section represent annual costs of control which will be incurred in 1987, when it is assumed that the control measures will be applied fully to the applicable sources. The annual costs include operating, maintenance and administrative costs as well as annualized capital charges that take into account depreciation and interest costs. No estimates are made of the total capital costs that will result from application of the control measures outlined. In addition, secondary costs and benefits associated with control measures are not estimated.

4.1 COSTS FOR THE FEDERAL MOTOR VEHICLE CONTROL PROGRAM

The Federal Motor Vehicle Control Program (FMVCP) includes tailpipe emission standards for hydrocarbons (HC), carbon monoxide (CO), and nitrogen oxides (NOx) from motor vehicles. Since control of HC and CO occurs simultaneously with catalyst control, it is not possible to allocate specific control for either pollutant. Thus, it also is not possible to allocate the costs of control between the pollutants. The costs estimated below pertain to both HC and CO control.

Control of HC and CO to the statutory limits for light duty vehicles will involve an installed cost of about $125 per vehicle for model years 1975-81 and an installed cost of approximately $218 per vehicle for model years 1982-87.[1] These unit costs are combined with estimates of the composition of the vehicle fleet for the 90 AQCRs in 1987 with respect to model year in order to estimate national costs of the program. The annual cost in 1987 for the 90 AQCRs is estimated to be $2.8 to $3.0 billion, which will be the cost irrespective of the level of the standard.[2]

4.2 COSTS FOR NEW AND MODIFIED STATIONARY SOURCES

Appendix C presents a discussion of the many sources of hydrocarbons and the control techniques that are available. An analysis of the costs of these techniques for each source of emissions has been made and a summary is also presented in Appendix C. These costs are current as of July 1977.

Since all of the sources considered in Appendix C fall into the broad categories of chemical manufacturing, petroleum industries or solvent evaporation sources, it is assumed that only industries in these categories will be subject to controls on new and modified sources. In order to estimate the average cost per ton of hydrocarbons controlled for the general source categories, the individual stationary sources contained in Appendix C were segmented into the three source categories. The average cost per ton controlled for each category represents a weighted average based on the cost per ton and the net reduction in emissions (in tons) achievable with RACT (from Appendix D) for each source. The average costs are summarized as follows:

° Chemical Manufacturing	$100/ton
° Petroleum Industries	0 (costs are offset by product recovery)
° Solvent Evaporation	$150/ton

To obtain total new source costs for each AQCR, the average cost per ton is multiplied by the emission reductions for the source categories due to the control of new and modified sources. The total national costs of new source control, which represents the sum of the costs for the 90 AQCRs, amount to an annual cost of approximately $900 million to $1.3 billion, of which more than 95 percent comes from solvent evaporation sources while the rest comes from chemical manufacturing sources.

4.3 COSTS OF APPLYING RACT FOR ALTERNATIVE STANDARDS

4.3.1 Cost-effectiveness of Reasonably Available Control Measures

The approach for determining the average cost per ton controlled for the sources for which RACT is applicable is the same as the approach outlined in the previous section for new sources. The bases for the costs are discussed in detail in Appendix C. The weighted average cost of RACT for the source categories is summarized in Table 4-1.

The unit costs for transportation sources were derived somewhat differently than for stationary sources. For light-duty vehicles, the cost-effectiveness of an inspection/maintenance is estimated to be about

$340 per ton of hydrocarbons removed at current automotive emission levels.[3] As the emissions of new cars are reduced with statutory requirements, though, the cost per ton will increase as there are less baseline emissions to reduce. It is estimated that by 1987 the average cost effectiveness of inspection/maintenance will be $420 per ton. Since the cost of traffic reduction measures are extremely variable, for purposes of this study it is assumed that reasonable aspects of these measures can be instituted for around $1000 per ton. Traffic reduction measures for other highway vehicles are also expected to be costly since it will be difficult to affect reductions in vehicle miles traveled for these sources. Once again, the cost of these measures will be extremely variable, but a cost of $1000 per ton is assumed for analytical purposes.

4.3.2 Analytical Methodology

For each alternative standard, maximum allowable 1987 emission levels are calculated for each AQCR based on 1975-1977 expected air quality levels, 1975 total emissions of non-methane hydrocarbons, the level of the alternative standard and assumed relationships between NMHC emissions and ambient ozone concentrations using both the linear rollback model and the Empirical Kinetic Modeling Approach (EKMA). The allowable emissions for each AQCR are then compared to the projected 1987 emission levels, based on the national estimates of growth and retirement rates and new source emission levels for each source category over the 12-year interval. If projected emissions are greater than allowable emissions, existing source emissions (i.e., those that have not been replaced) are reduced appropriately due to RACT and RACT costs are computed. The costs are obtained by multiplying the average cost per ton for RACT for each general source category (see Table 4-1) by the emission reduction due to RACT for each category.

If controlled 1987 emissions are less than allowable emissions for alternative standards, the application of total RACT is unnecessary. In this case, the source categories are partially decontrolled in a manner which minimizes total control costs. This involves applying controls to the source categories in order of the most cost-effective first.

After the costs for each individual AQCR have been determined, the AQCR costs are then summed in order to arrive at national costs. The costs presented are only for those existing sources which have not been replaced by 1987 and does not include the costs of controls on replaced sources, which is included in the new source costs presented earlier.

4.3.3 Total Costs

The total annualized costs in 1987 of applying RACT in the 90 nonattainment AQCRs are presented in Table 4-2. The costs differ for alternative levels of the standard since as the level becomes less stringent more areas can attain the standard without applying full RACT. In addition, the costs differ depending upon the modeling technique used. Rollback, using the assumptions in this report, generally requires less control than EKMA and thus more AQCRs are able to attain the alternative levels of the standard.

Table 4-1. AVERAGE RACT CONTROL COSTS[a]

Source	Control Costs ($ per ton)
Transportation Sources	
Light Duty Vehicles[b]	$530
Other Highway Vehicles	1000[c]
Non-Highway Vehicles	--
Oil and Gas Marketing	275
Stationary Sources	
Fuel Combustion	--
Chemical Manufacturing	100
Petroleum Industries	0[d]
Other Industrial Processes	0
Solvent Evaporation	
- Identified RACT	150
- Advanced RACT	300[e]
Solid Waste	--
Miscellaneous	--

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[a] Data on control costs for reasonably available control technology are taken from Appendix C.

[b] Does not include cost of tailpipe controls, which are assumed as given and are included earlier in the costs of FMVCP.

[c] The RACT control for this category is traffic reduction. The estimate of average cost is a very rough approximation. Only sparse and usually site-specific information available for verification.

[d] Costs are offset by credit due to product recovery.

[e] Based on cost of $150/ton for identified sources and $500/ton for additional sources.

Table 4-2. ANNUAL CONTROL COSTS IN 1987 OF APPLYING RACT IN 90 AQCRs FOR ALTERNATIVE STANDARD LEVELS
($ Billions)

	Rollback Model		EKMA	
Level of Standard	Identified RACT	Advanced RACT	Identified RACT	Advanced RACT
.08 ppm	0.8-1.0	1.3-1.7	0.9-1.1	1.5-1.9
.10 ppm	0.6-0.8	0.9-1.3	0.8-1.1	1.4-1.8
.12 ppm	0.4-0.6	0.6-0.9	0.6-0.9	1.0-1.4
.14 ppm	0.3-0.4	0.4-0.6	0.5-0.7	0.9-1.2

Utilizing the rollback model, costs of applying RACT at existing identified sources range from up to $1.0 billion per year for a .08 ppm down to about $300 million per year for .14 ppm. For EKMA, the estimated 1987 annual costs for identified sources range from $1.1 billion for .08 ppm down to $500 million for a .14 ppm. The difference in costs between alternative standards is not as great as might be expected, especially under EKMA, because reductions in costs occur only in those areas which meet the particular standard without having to apply full RACT. For instance, under EKMA, from 20 to 40 percent of the AQCRs under consideration are not predicted to achieve either a .08 ppm standard or a .12 ppm standard. Since these areas have to apply full RACT for both standards, this results in the same cost of control for the areas. This concept also explains why the cost differences between alternative standards are not as great under EKMA since so many areas have to apply full RACT regardless of the level of the standard.

For "advanced" RACT, the costs are naturally greater since more sources are being controlled at a higher cost. Based on the rollback results, the costs range from up to $1.7 billion for a .08 ppm level to a low of $400 million for a .14 ppm level. The costs are greater with EKMA and there is not as much difference in costs due to alternative standard levels.

4.4 SUMMARY OF COSTS FOR FMVCP, NEW SOURCE CONTROL, AND RACT ON EXISTING SOURCES

Tables 4-3 and 4-4 summarize the costs discussed thus far in this chapter, depending upon the modeling technique used. As can be seen, the

Table 4-3. SUMMARY OF COSTS FOR FMVCP, NEW SOURCE CONTROL, AND RACT ON EXISTING SOURCES ($ BILLIONS) (Rollback)

Level of Standard	Costs of FMVCP	Costs of New Source Control	Identified RACT		Advanced RACT	
			Cost of RACT	Total Costs[a]	Cost of RACT	Total Costs[a]
.08 ppm	$2.8-3.0	$0.9-1.3	$0.8-1.0	$4.5-5.3	$1.3-1.7	$5.0-6.0
.10 ppm	2.8-3.0	0.9-1.3	0.6-0.8	4.3-5.1	0.9-1.3	4.6-5.6
.12 ppm	2.8-3.0	0.9-1.3	0.4-0.6	4.1-4.9	0.6-0.9	4.3-5.2
.14 ppm	2.8-3.0	0.9-1.3	0.3-0.4	4.0-4.7	0.4-0.6	4.1-4.9

[a] Total costs represent sum of costs for FMVCP, new source control, and appropriate RACT.

Table 4-4. SUMMARY OF COSTS FOR FMVCP, NEW SOURCE CONTROL, AND RACT ON EXISTING SOURCES ($ BILLIONS) (EKMA)

Level of Standard	Costs of FMVCP	Costs of New Source Control	Identified RACT		Advanced RACT	
			Cost of RACT	Total Costs[a]	Cost of RACT	Total Costs[a]
.08 ppm	$2.8-3.0	$0.9-1.3	$0.9-1.1	$4.6-5.4	$1.5-1.9	$5.2-6.2
.10 ppm	2.8-3.0	0.9-1.3	0.8-1.1	4.5-5.4	1.4-1.8	5.1-6.1
.12 ppm	2.8-3.0	0.9-1.3	0.6-0.9	4.3-5.2	1.0-1.4	4.7-5.7
.14 ppm	2.8-3.0	0.9-1.3	0.5-0.7	4.2-5.0	0.9-1.2	4.6-5.5

[a] Total costs represent sum of costs for FMVCP, new source control, and appropriate RACT.

total costs of the measures considered vary relatively little with alternative standards. For identified RACT, total costs ranging from a low of $4.08 billion with rollback at .14 ppm to a high of $5.4 billion with EKMA at .08 ppm. This difference is not great when one considers that the total costs for any standard level vary up to $.08 billion. The differences are somewhat greater for "advanced" RACT. While the costs range from $4.1 billion with rollback at .14 ppm to a high of $6.2 billion with EKMA at .08 ppm, the total costs at any standard level can vary by as much as a billion dollars.

Regardless of modeling technique the reason for these relatively small differences for alternative standard levels are twofold. First, the vast majority of the total costs ($3.7 to $4.3 billion) result from the FMVCP and new source controls, which are assumed to be the same regardless of the level of the standard. Secondly, the RACT control costs do not differ greatly from alternative standards since many areas have to apply full RACT regardless of the level of the standard. One point to remember though is that these costs do not represent the cost for all 90 AQCRs to attain the standard. AQCRs which fail to attain the alternative standards will have to apply additional control measures, which will result in a larger difference between the costs associated with the alternative levels of the standard.

4.5 ESTIMATED COST OF ATTAINMENT

As discussed in Chapter 3.0, many AQCRs will not attain alternative levels of the standard by applying the control measures outlined in this report. Thus, additional control measures will be needed in some areas in order to reduce emissions even further so that the standards can be attained. These measures could include restrictive transportation control measures that significantly reduce vehicle miles traveled in urban areas, control of stationary sources for which RACT has not been identified or defined, and tighter controls on new and existing sources than those achievable with RACT. The cost-effectiveness of these measures has not been estimated, though on the whole they are believed to be more costly than current measures that have been defined. While some measures can no doubt be implemented at costs approaching the level of RACT costs identified earlier, many measures are likely to be much more costly. For example, traffic reduction plans are extremely area specific and it is likely that application of such measures could cost up to several thousand dollars per ton of emissions controlled, though by the same token they could cost much less. Likewise, the control of the many solvent evaporation sources that have yet to be identified is likely to be more costly since these sources tend to be relatively small and difficult to control from a technical standpoint. For instance, the cost to control small coin-op drycleaners is estimated to be about $5000 per ton of solvent controlled.[4] Finally, the cost of applying more stringent controls in place of RACT on new and existing stationary sources is likely to be high due to higher marginal costs of control. Moving to more stringent levels of control for particular sources will involve exponentially higher costs for a relatively small reduction in emissions. For example, the marginal cost of achieving 95 percent control at service stations versus 90 percent control is likely to be greater than $5000 per additional ton removed.[5]

Even though the costs of additional control measures are not known, it is still useful to estimate the cost of attainment is some manner in order to better indicate the cost differences between alternative standards. To do this, a cost-effectiveness estimate of $1,000 to $1,500 per ton controlled is assumed for the additional emissions reductions past "advanced" RACT required for each AQCR to attain the alternative standards. While there are likely to be many measures that are more costly than this, it is also quite possible that many measures may be applied at cost levels approaching projected RACT costs discussed earlier in this study. The $1000-$1500 per ton figure represents a compromise between the extreme estimates.

To determine the total cost of attainment in all 90 AQCRs, the additional emission reduction required (from Table 3-4) is multiplied by $1,000 to $1,500 per ton, with the resulting costs added to the costs summarized previously in Tables 4-3 and 4-4. The estimated costs of attainment are presented in Table 4-5. Employing the rollback model, the total cost of attainment for a .08 ppm standard is estimated to range between $6.0 and $8.0 billion, falling to $5.0 to $6.5 billion, $4.5 to $5.5 billion, and $4.0 to $5.0 billion for a .10 ppm, .12 ppm, and .14 ppm standards, respectively. The costs using EKMA are higher, ranging from $5.0 to $6.5 billion for a .14 ppm to between $9.0 and $12.5 billion for .08 ppm. In addition to the assumed cost-effectiveness of additional controls making the cost differences conservative, the differences may also be somewhat understated due to the fact that more stringent levels of the standard are

Table 4-5. ESTIMATED COST FOR ALL 90 AQCRs TO ATTAIN ALTERNATIVE STANDARDS
($ Billions)

	ROLLBACK			EKMA (CONSTANT NOx EMISSIONS)		
Level of Standard (ppm)	Cost of FMVCP New Source Control, and Advanced RACT[a]	Cost of Additional Reduction Required[b]	Total Cost of Attainment	Cost of FMVCP New Source Control, and Advanced RACT[a]	Cost of Additional Reduction Required[b]	Total Cost of Attainment
.08	$5.0-6.0	$1.2-1.8	$6.2-7.8	$5.2-6.2	$4.1-6.2	$9.3-12.4
.10	4.6-5.6	0.5-0.8	5.1-6.4	5.1-6.1	1.8-3.0	6.9-9.1
.12	4.3-5.2	0.2-0.3	4.5-5.5	4.7-5.7	0.8-1.2	5.5-6.9
.14	4.1-4.9	0.1-0.2	4.2-5.1	4.6-5.5	0.5-0.8	5.1-6.3

[a] From Tables 4-3 and 4-4.

[b] Emission reduction from Tables 3-5 and 3-6 multiplied by $1000-1500/ton, which is a lower-bounds estimate.

likely to require more sophisticated and extensive, and thus more costly, controls. The approach used in this section does not take into consideration such differences.

4.6 REFERENCES FOR CHAPTER 4.0

1. Environmental Protection Agency, Auto Emission Control: Current Status and Development Trends as of March 1976.

2. Personal Communication from Dale L. Keyes, Energy and Environmental Analysis, Inc., Arlington, Virginia, to Kenneth H. Lloyd, Strategies and Air Standards Division, OAQPS, EPA, May 30, 1978.

3. Walsh, M.P., Mobile Source Enforcement Division, EPA, "The Need for and Benefits of Inspection and Maintenance of In-Use Motor Vehicles", November 9, 1976.

4. Environmental Protection Agency, Control of Volatile Organic Emissions from Dry Cleaning Operations, Draft, April 1977.

5. Lloyd, Kenneth H., Economic Analysis Branch, OAQPS, EPA, "Cost of Alternative Vapor Recovery Systems at Service Stations," October 20, 1977.

5.0 ECONOMIC IMPACT OF REASONABLY AVAILABLE CONTROL MEASURES ON SELECTED INDUSTRIES

5.1 INTRODUCTION

Control measures to reduce emissions of hydrocarbons and other volatile organic compounds will affect many industries in the U.S. economy. In addition to major industries such as chemical manufacturing, petroleum refining and automobile production, control measures will affect many small industries which use petroleum products or organic solvents in a wide range of applications. Countless industries which produce consumer products use solvents in coating operations, while many industries use solvents in metal and product cleaning. For examples of the industries affected by control measures for hydrocarbons, consult Appendix D.

An analysis of the economic impact of the revised standard on the numerous industries affected is not possible to complete in the time frame available for analysis. However, EPA has conducted economic impact studies for the major emission sources, though these constitute only a portion of the total number of sources affected. Economic analyses of all affected industries are being initiated and significant results are expected within two to three years. The Clean Air Act does not permit the consideration of costs and economic impact in the setting of health related national ambient air quality standards. The incomplete character of the economic impact analysis for all affected sources does not mitigate EPA's legal burden to propose the standard now.

Nonetheless, an attempt has been made to give an indication of the economic impact of reasonably available control measures on selected industries. These are industries for which EPA has conducted previous cost or economic studies and for which quantitative or qualitative economic judgements can readily be made.

5.2 PETROLEUM REFINING

5.2.1 Industry Profile

Crude petroluem is refined by 150 companies at 266 refineries located in 40 different states. Production of refined products in the U.S. totalled over 15 million barrels per day in 1976, or 93 percent of nameplate capacity.[1] The industry employs 100,000 workers and is heavily concentrated in the West South Central region of Arkansas, Oklahoma, Texas, and Louisiana. These four states employ 44 percent of all industry workers and supply 43 percent of all refined products. Refineries tend to be concentrated in areas of the country that have oxidant levels that currently exceed the standard.

The petroleum refining industry is somewhat concentrated. The five leading producers own 36.5 percent of all industry capacity; the top ten, 58.5 percent. These leading producers are integrated, major oil companies that engage in exploration, production, refining, distribution, and marketing on the retail level. Other refiners are independent companies that are typically not integrated into more than one other segment of the industry. Prices vary little among companies, although there are occasional examples of price cutting when there is weak demand and an excess of supply.

5.2.2 Costs of Reasonably Available Control Measures

Petroleum refineries are significant sources of volatile organic compound (VOC) emissions. The major point sources of VOC emissions from petroleum refineries are vacuum producing systems (VPS), wastewater separators (WWS), process unit turnarounds (PUT), and leaks from miscellaneous sources such as pumps, compressors, and valves. EPA has analyzed control techniques for these sources, which reduce emissions by 95 to 100 percent. For vacuum producing systems, control can be achieved by venting the emissions to a firebox. Large reductions in emissions can be accomplished for the wastewater separators through covering the separators and forebays. Emissions can be controlled from process unit turnarounds by piping the VOC to a flare or to the fuel gas systems. Finally, emissions from miscellaneous equipment can be substantially controlled by reducing equipment leaks with a monitoring and maintenance program.

Costs of these control measures have also been estimated by EPA based on analysis of a model sized refinery with a throughput of 100,000 barrels per day.[2] Costs for individual refineries will vary considerably due to differences in size, configuration and age of facilities, product mix, and degree of control.

The capital cost for piping for controlling emissions from vacuum producing systems will range from $23,700 to $51,600, depending on whether the system uses surface condensers or contact condensers. However, this control measure should result in an annual savings of $89,000 to $96,700 due to significant credits for the value of the recovered petroleum. For wastewater separators, the capital cost of covers for the facilities will be approximately $62,800, but again due to the value of the recovered petroleum products, a net annual savings of $309,700 should result. The control method for process unit turnarounds has an estimated capital cost of $97,600 for piping and valves. Petroleum product recovery is not as readily recoverable from this control measure, though some refineries currently have facilities for recovering the hydrocarbons. Nonetheless, assuming no recovery of petroleum products, an annualized cost of approximately $25,900 will result. The total capital cost for these three sources will range from $184,000 to $212,000. However, this capital outlay is more than offset by the annual recovered petroleum credits valued at $432,000, which does not include the value of recovered PUT emissions.

Finally, the cost of a monitoring and maintenance program to detect and control equipment leaks has also been estimated.[3] For a model 100,000 barrel per day refinery, the capital cost for monitors will approximate $8,600. The annualized cost of a program, taking into account monitoring and maintenance labor, materials, and capital charges, will be about $103,000. This annualized cost, though, should be offset to some degree by recovery credits of reduced emissions. However, emission reduction factors are not presently quantifiable and thus recovery credits will be extremely variable.

5.2.3 Economic Impact of Control Measures

The economic impact of the control measures outlined in the previous section is expected to be small for several reasons. First, the capital costs are not large in comparison with the capital cost of a refinery as a whole. The capital cost for a model refinery with a throughput of 100,000 barrels per day is estimated to range from $300 million to $500 million.[4] A capital outlay of $220,000 for the VOC control measures represents an insignificant increase (less than 0.1 percent) in the capital cost of a refinery.

Secondly, the value of recovered petroleum products offsets the capital costs entirely in the first year. Thus, the controls can be justified solely on economic grounds. Lastly, the economic impact should not be large since a significant portion of the industry has already instituted the controls. Twenty-five percent of the industry already controls vacuum producing systems, 80 percent controls wastewater separators, and 40 percent controls process unit turnarounds.[5] Finally, a comprehensive study of the petroleum refining industry indicates that EPA's total air and water pollution regulations will result in only a small impact on this sector.[6]

5.3 RETAIL GASOLINE SERVICE STATIONS

5.3.1 Industry Profile

In 1977, there were approximately 178,000 gasoline stations in the U.S. Over 48,000 service stations have closed in the U.S. since the population peak of 226,000 in 1972. This attrition is expected to continue at least through the early 1980's to a leveling off point of anywhere from 125,000 to 150,000 outlets. The economies of scale of high volume stations and the shift to self-service operations are a prime factor in shrinking retail margins. Consequently, the closure of outlets due to market rationalization processes will be most severe for those outlets which have relatively low sales volume coupled with high unit expenses.

Major oil companies and regional refiner/marketers supplied over half of the retail service stations in the country with the remaining 43 percent supplied by independent marketers. The traditional retail marketing strategy of major oil companies has been to operate through lessee dealers. These lessee outlets still represent approximately two-thirds of the major oil company stations and almost 50 percent of all stations in the country. The second largest group of outlets are known as open dealers. In these operations, the onsite dealer actually owns or controls the investment in his station where he is physically employed. Open dealers represent over one-third of the retail outlets in the U.S. They are generally branded (i.e., station operating under the brand identification of a major oil company) and supplied either directly by a major oil company or a branded jobber. The other types of retail operations are direct salary outlets and convenience stores, which are low expense, low margin operations which account for less than 25 percent of the total population of gasoline retailers. A summary of the service station market segments is presented in Table 5-1.[7]

Retail service stations dispense an average of about 40,000 gallons per month. In recent years, marketing economics have resulted in a trend toward stations with larger volumes, with small volume operations being marginal operations that have to rely on other parts of the retail trade, such as mechanical work and sales of accessories, in order to remain in business. The high volume stations tend to be mostly direct operations

Table 5-1. 1977 U.S. SERVICE STATION POPULATION

	Number of Outlets (%) Type of Operation				
Supplier	Direct	Lessee	Open Dealer	Convenience Store	Total
Major	6,400 (3.6%)	50,200 (28.2%)	27,800 (15.6%)	700 (0.4%)	85,100 (47.8%)
Regional Refiner	4,100 (2.3%)	9,400 (5.3%)	2,000 (1.1%)	200 (0.1%)	15,700 (8.8%)
Independent Marketer/ Wholesaler - Super Jokker"	16,600 (9.3%)	4,400 (2.5%)	1,100 (0.6%)	7,700 (4.3%)	29,800 (16.7%)
Small Jobber	5,000 (2.8%)	19,400 (10.9%)	21,900 (12.3%)	1,100 (0.6%)	47,400 (26.6%)
	32,100 (18.0%)	83,400 (46.9%)	52,800 (29.6%)	9,700 (5.4%)	178,000 (100.0%)

which are controlled and operated by the supplier and operate on relatively low margins. Low volume stations, those dispensing less than 25,000 gallons per month, are mostly lessee dealers and open dealers supplied by all classes of suppliers. These low volume stations, which comprise close to 50 percent of the total number of stations, are the segment of the retail industry that is most vulnerable to changes in marketing economics as well as external costs such as vapor recovery costs.

✓ 5.3.2 Cost of Reasonably Available Control Measures

Emissions occur from two major sources at service stations - the loading of underground storage tanks (Stage I) and the refueling of motor vehicles (Stage II). For Stage I emissions, vapors can be controlled through the use of a vapor balance system, where vapors are vented by displacement to an intermediate holding area (usually the tank truck) for ultimate disposal or recovery at the bulk terminal or bulk plant. Stage II emissions can be controlled through a variety of systems, the most basic of which is the balance system where vapors from the refueling operation are displaced by means of a tight fitting nozzle and vapor return lines to the underground tank. More elaborate recovery systems create a vacuum whre vapors are drawn from the refueling operation, alleviating the need for a tight nozzle fit. Vapors are again displaced to the underground storage tanks, with the excess vapors being incinerated in most cases. There are several variations of this vacuum assist system which are too numerous and involved to discuss here.

Since vapor balance systems are less costly than vacuum assist systems and control anywhere from 80 to 90 percent of the emissions, only the costs of the balance systems are included in this analysis. The capital costs of the system varies with the number of dispensers at the station, the number of underground tanks, and the physical layout of the station. For a typical nine dispenser, three island station, the capital costs will approximate $8,800. These costs can range from $4,500 for a two-dispenser station to over $11,000 for a 15-dispenser facility.[8]

Essentially the only operating and maintenance cost associated with the balance system is that for nozzle maintenance since the system does not require any power to operate and there are no moving parts associated with the remainder of the system. Nozzle maintenance requirements will be extremely variable depending on a number of factors. However, it is expected that the nozzle will have to be replaced only once a year or the faceplate and/or boot repaired or replaced no more than twice a year. This would result in an annual maintenance cost of about $60 per nozzle, or about $540 for a nine-nozzle station.

Since the vapor balance system is characterized by a high fixed cost component, the annualized cost per gallon of throughput is naturally highly dependent on the volume of the station and the cost of investment capital for the station. Costs range from about 0.1 cent per gallon for high-volume direct operations to over one cent per gallon for low-volume open dealer. Costs for other low volume outlets range from 0.5 to 0.6 cent per gallon while other medium to high volume outlets have costs ranging from 0.2 to 0.4 cent per gallon.

5.3.3 Economic Impact of Control Measures

The direct economic effect of vapor recovery at service stations is to reinforce the existing economies of scale in gasoline marketing. The competitive position of high volume outlets may be strengthened since their economics will not be significantly affected. On the other hand, low volume outlets which are already marginal operations will have their position eroded even further, even though it is expected that most of these marginal stations will close in the next five years regardless of the requirement of vapor recovery due to unfavorable station economics.

While the costs for the balance system are insignificant to the consumer, the costs are still of appreciable magnitude to the dealer, who typically has a profit margin of one cent or less per gallon on gasoline. Thus, in some instances, vapor recovery costs could entirely wipe out profit margins and in other cases severely reduce the margin by over 50 percent. In addition, some owners of stations may have difficulty obtaining the capital necessary to finance the vapor recovery equipment. Highly leveraged firms may not have the capacity to absorb additional debt and thus could not obtain loans. This aspect is particularly crucial to large independent marketers who typically own anywhere from 20 to 100 stations and hence would have to come up with a sizable sum of investment capital for vapor recovery systems.

It is difficult to segregate the marginal stations which will eventually survive in the marketplace but would have to close with the requirement of vapor recovery. In a study conducted for EPA and OSHA by Arthur D. Little, Inc., an attempt was made to estimate the number of closures nationwide which would result due to market forces, due to capital availability constraints for vapor recovery investment, and finally due to the impact of the vapor recovery costs on the profitability of stations.[9] The analysis indicated that over 20 percent of the current population could close by 1981 due solely to market forces, with over 75 percent of closures resulting in the lessee dealer segment of the market. Vapor recovery requirements, on the other hand, would result in additional closures representing about six percent of the current population, or just over 10,000 stations nationwide. Around 12 percent of these vapor recovery-induced closures would be in the large independent segment of the market where companies with large numbers of stations would be unable to obtain the required investment to finance vapor recovery systems at all their stations. The remainder of the closures would be open dealers for whom the increased costs would severely reduce or eliminate profit margins and make staying in business unattractive. The closures in this segment of the market would represent about 17 percent of the total open dealer stations.

5.4 GASOLINE BULK PLANTS

5.4.1 Industry Profile

Bulk gasoline loading plants are typically secondary distribution facilities which receive gasoline from bulk terminals by trailer transports, store it in above-ground tanks, and subsequently dispense it via account trucks to local farms, businesses, and service stations. Bulk plants may be owned by a major or independent petroleum refiner, an independent jobber, or an individual operator. Although operation and ownership of bulk plants include cooperatives and salaried employees, the predominant types are the independent jobber and the commission agent who operates the plant for a larger refiner but owns his own delivery trucks.

Currently there are less than 20,000 bulk plants in operation in the U.S. with almost half having daily throughputs less than 4,000 gallons. This represents a decline of nearly 4,000 stations facilities from the population in 1972. This trend is expected to continue as major oil companies dispose of their many bulk plants as they decline in importance in gasoline distribution and become less profitable. While bulk plants served useful pruposes in years past, their role in the distribuiton chain have declined since more stations are receiving deliveries directly from bulk terminals. Bulk plants are being bypassed since economies of labor and capital can be realized if the transport truck can deliver directly from the terminal to an account, thus reducing the cost of gasoline to the station by an appreciable amount. Another important factor in the decline of bulk plants has been and will continue to be a decline in the customer population served by bulk plants. Small stations and commercial accounts which once depended upon bulk plants are also undergoing a significant attrition in the retail market. Even commercial accounts once served by bulk plants are receiving deliveries directly from terminals. No estimates are available which indicate what the bulk plant population will be in the next five years or once the market rationalization process is completed, though it is expected to be significantly less than the current population.

5.4.2 Cost of Reasonably Available Control Measures

Control of breathing, working and miscellaneous losses resulting from storage and handling of gasoline at bulk plants can be accomplished through submerged fill, balance systems, vapor processing systems and control of truck loading leaks. Vapor processing systems have not been applied to bulk plants, but have been used to recover hydrocarbon vapors at bulk terminals during truck loading.

By changing from top splash loading to submerged fill, vapors generated by loading tank trucks can be reduced by about 58 percent. Submerged fill decreases turbulence, evaporation, and eliminates liquid entrainment. The cost to install submerged fill at the typical plant with three loading arms is less than $1,000. This cost is more than offset by the cost savings that result from the elimination of the generation of vapors during loading.

The vapor balance system operates by transferring vapors displaced from the receiving tank to the tank being loaded. A vapor line between the truck and storage tanks essentially creates a closed system permitting the vapor spaces of the two tanks to balance with each other. In addition, vapor balancing of incoming transport trucks displaces vapors from the storage tanks to truck compartments, with the emissions ultimately being treated at the terminal with a secondary recovery/control system. The vapor balance system can reduce emissions from the bulk plant by around 90 percent.

The capital costs for vapor balance systems at bulk plants will vary depending upon a number of factors, such as the configuration of the plant, age and condition of tanks, and requirements for additional equipment due to local regulations such as fire laws. In areas where these regulations are less restrictive, vapor balance costs are substantially lower. Based on an analysis of costs from various sources, EPA estimates the capital costs for converting to submerged fill and installing the cheaper vapor balance systems to be around $4,000 for a 4,000 gallon per day (gpd) facility and $5,000 for a 20,000 gpd plant. Except to a minor extent, these costs are not a function of throughput of the bulk plant since the number of tanks is relatively independent of throughput and the number of delivery trucks serviced is small. The annualized costs for these model facilities are offset by a credit for gasoline recovery. The credit, which includes only the savings for the emissions which are not generated in the first place as opposed to the vapors which are returned to the bulk terminal for processing, is naturally a function of throughput. The large bulk plant has a sizeable gasoline recovery credit.

In areas where local regulations prohibit use of the cheaper vapor balance systems, a more complete and expensive balance system will have to be installed. Capital costs for converting to submerged fill and installing the complete balance system would range from about $23,000 for a 4,000 gpd facility to close to $26,000 for a 20,000 gpd plant. The annualized costs for these model facilities amount to around $3,500 for the small plant (or about 0.3 cents per gallon) and about $750 for the large plant (less than 0.1 cent per gallon).

5.4.3 Economic Impact of Control Measures

The economic impact on bulk plant operators due to vapor recovery requirements depends on the system which can be installed at the plant. If the cheaper balance systems can be used, the capital costs are not of such magnitude as to cause a significant impact in the industry.

An economic impact analysis is being conducted by EPA which will quantify the potential impacts which could result from the range of vapor recovery system costs.

The magnitude of the costs for the more expensive balance systems will likely have a more significant impact on bulk plants. A capital outlay of around $23,000 represents a significant investment for small plants. Some sources have reported sales prices for bulk plants that have been sold by major oil companies which range between $45,000 and $65,000. Thus, investment for the expensive vapor balance systems represents one-third to one-half of these transaction prices.[10] A preliminary economic analysis prepared for EPA concludes that bulk plants having throughputs less than 4,000 pgd are either unprofitable or only marginally profitable and could possibly be unable to cope with an expenditure of this magnitude.[11] EPA's current analysis will better determine the extent of the potential impacts of these costs on small bulk plants.

When assessing impacts on bulk plants or potential closures of plants, it is important to consider several points. First, until SIP revisions are submitted, enforcement discretion is being utilized to prevent closures from occurring due to pollution control requirements. Guidance has been developed and provided to the states in developing the SIP revisions. Secondly, not all bulk plants in the country will be affected by vapor recovery regulations. Only bulk plants in non-attainment areas will be required to install controls. Since bulk plants are concentrated in rural areas, it is likely that a large number of bulk plants would not be required to install vapor recovery systems. Finally, most of the bulk plants that could be closed by vapor recovery requirements are likely to go out of business or dispose of their gasoline operations in the near future due solely to market forces. Hence, vapor recovery requirements could only accelerate closures that will take place even in the absence of such requirements.

5.5 AUTOMOBILE ASSEMBLY PLANTS

5.5.1 Industry Profile

In the model year 1976, over 8.5 million automobiles were sold by U.S. automakers. They represented a significant rebound from 1974 and 1975 sales levels when, respectively, only 7.3 and 6.7 million cars were sold. General Motors and Ford Motor Company dominate the industry as the two companies accounted for 58 and 24 percent of the autos produced in 1976, respectively. The other two major automakers, Chrysler and American Motors, accounted for 16 and three percent, respectively.[12]

There are currently 46 auto assembly plants in the U.S., though this number can vary due to temporary shutdowns and switchovers to light-duty truck assembly. GM has 22 of the plants while Ford has 14. The remainder of the plants are owned by Chrysler and AMC as well as Checker Motors and Volkswagen, which is opening a new plant in Pennsylvania. The locations of these plants are indicated in Table 5-2.[13] Essentially all of the plants are located in non-attainment areas for oxidants.

Table 5-2. U.S. AUTOMOBILE ASSEMBLY PLANTS

Manufacturer	Location
American Motors	Kenosha, Wisconsin
	Toledo, Ohio
Chrysler Corp.	Belvidere, Illinois
	Hamtramck, Michigan
	Detroit, Michigan
	Newark, Delaware
	St. Louis, Missouri
Ford Motor Co.	Atlanta, Georgia
	Chicago, Illinois
	Dearborn, Michigan
	Kansas City, Missouri
	Lorain, Ohio
	Los Angeles, Calif.
	Mahwah, New Jersey
	Metuchen, New Jersey
	St. Louis, Missouri
	San Jose, California
	Twin Cities, Minnesota
	Wayne, Michigan
	Wixom, Michigan
General Motors	Arlington, Texas
	Baltimore, maryland
	Detroit, Michigan
	Doraville, Georgia
	Fairfax, Kansas
	Flint, Michigan
	Framingham, Mass.
	Fremont, California
	Janesville, Wisconsin
	Lakewood, Georgia
	Lansing, Michigan
	Leeds, Missouri
	Linden, New Jersey
	Lordstown, Ohio
	Norwood, Ohio
	Pontiac, Michigan
	St. Louis, Missouri
	South Gate, Calif.
	Tarrytown, New York
	Van Nuys, California
	Willow Run, Michigan
	Wilmington, Delaware
Checker Motors	Kalamazoo, Michigan
Volkswagen	Pennsylvania

The earnings of the automakers sagged in 1974 and 1975 due to reduced sales levels. However, in 1976 earnings expressed as return on equity or return on assets returned to historical levels, though American Motors is still experiencing financial difficulties.

5.5.2 Cost of Reasonably Available Control Measures

For the paint coating of auto bodies at assembly plants, numerous options exist for the control of VOC emissions, with control ranging from 70 to 95 percent. Options potentially consist of process changes, such as electrodeposition (EDP) of the primecoat and water-borne topcoats, and add-on control devices such as carbon adsorption, thermal incineration, and catalytic incineration. For purposes of this study, the most cost-effective control options for prime and top coating were chosen that resulted in at least 80 percent control. Other control options could possibly be chosen in actual existing plants, but this analysis considers only the least costly option, based on costs furnished to EPA by Springborn Laboratories.[14] The following control option was chosen:

- Prime coating: EDP with water-borne dip and solvent guide coat
- Prime and top coat spray booths: Catalytic incineration with primary heat exchange
- Prime and top coat ovens: Catalytic incineration with primary heat exchange.

Add-on controls in addition to EDP are needed for the prime coating operation in order to control emissions from the application of the solvent guide coat.

Costs for these options have been estimated for a "model" auto assembly plant producing 211,200 bodies per year. The capital cost of converting the plant to EDP and adding the control devices is estimated to be about $20.2 million, with $15.7 million resulting from the conversion to EDP, $0.8 million from the prime coat add-on devices, and $3.7 million from the top coat add-on controls.

Annualized costs have also been estimated taking into account operating and maintenance costs of the processes and devices as well as the depreciation and interest charges. Only the incremental O&M costs incurred over the existing base case (solvent-borne prime and otp coats with no control) are included in the estimates. However, the entire capital charges of the new processes and devices are included since it is assumed that the existing equipment has no salvage value. Salvage values will vary significantly from plant to plant and thus it is difficult to generalize on an appropriate value. Based on these assumptions, the increased annualized cost of control is estimated to be almost $34 per car.

5.5.3 Economic Impact of Control Measures

EPA is conducting but has not completed a formal study of the economic impact of these controls on the automobile industry. However, tentative conclusions can be drawn.

Currently, about 60 percent of the assembly plants employ EDP to apply prime coats. Since this process change contributes almost half of the annualized cost per body, many of the existing plants will be able to achieve the required additional control for about $18 per car. In addition, due to the fact that such a large portion of the industry has already moved to EDP for economic and technical reasons the economic impact of such a switch for the remainder of the industry should not be unduly burdensome.

The impact on sales of automobiles is not expected to be significant. Rough estimates based on the Ford Econometric Sales Forecasting Model indicate that a $34 increase in the cost of the average automobile could result in a reduction in sales of 0.2 percent in 1983.[15] This is not a reduction in sales from current levels, but rather a reduction in levels that would otherwise occur in 1983. Such a reduction in foregone sales will have a negligible effect on the return on investment in the industry.

It is important to remember that these general conclusions are based on model plants and average conditions in the industry. Though none of the major firms are expected to experience serious impacts, some individual plants will experience more costly conversions to alternative processes which could affect their viability. A determination of the individual plants which have the potential to be severely impacted has not been determined and is beyond the scope of this analysis.

5.6 METAL FURNITURE INDUSTRY

5.6.1 Industry Profile

The metal furniture industry consists of about 1600 firms employing nearly 100,000 people and producing around $3.4 billion in metal furniture shipments in 1975.[16] The industry is highly fragmented, including the following categories of products: household metal furniture, office metal furniture, public building furniture, and metal partitions and fixtures. Around 500 firms manufacture household furniture, another 500 manufacture partitions and fixtures, over 400 produce public building furniture, and 200 firms engage in office furniture manufacture.

The industry is characterized by relatively small manufacturers. Whereas single-unit firms, those with one establishment for both manufacturing and administration, account for only 19 percent of the value of shipments for all manufacturing establishments listed by the Census of Manufacturers, such firms account for over double the average for household furniture, public building furniture, and partitions and fixtures. Only the office furniture segment of the market is consistent with the overall industry average. In addition, over 85 percent of all metal furniture establishments employ less than 100 people. In fact, more than 50 percent of the establishments in segments other than office furniture have less than 20 employees, according to the 1972 Census of Manufacturers.[17] The significant number of small firms indicates that no economies of scale are evident which prohibit small manufacturers from competing, especially in regional markets where low labor productivity may be overcome by lower distribution costs.

The manufacturing markets of metal furniture facilities vary. Some plants manufacture furniture to be sold directly to consumers through retail stores. In contrast, job shops, which produce furniture on a contract basis, apply coatings on many different furniture pieces according to the customer's specifications.

Metal furniture plants are located throughout the U.S. However, the states of Illinois, California, Michigan, New York, and Pennsylvania contain over 50 percent of the establishments in the industry.

5.6.2 Costs of Reasonably Available Control Measures

Measures to reduce volatile organic emissions from metal furniture coating operations consist of process changes as well as exhaust gas treatment with add-on control devices. Applicable process changes include conversion to waterborne coatings, high solids coatings, powder coatings, and electrodeposition (EDP) of waterborne coatings. Add-on control devices include carbon adsorption and incineration. While each of these measures achieves reasonable levels of control, the option chosen by an individual plant will depend upon circumstances specific to the plant.

EPA has estimated costs of the alternative measures on the basis of model plants in order to indicate the relative costs of the alternatives.[18] These models are one-color lines and are sized based on the annual product coverage rates for the coating lines.

For electrostatic spray lines, the most feasible control option appears to be conversion to high solids coatings in order to reduce solvent emissions. The reduction can range from 50 to 90 percent depending upon the type of coating used previously. For a three million square feet per year coating line, the capital cost to convert the line is approximately $15,000, while for a large plant (48 million square ft/yr) the capital cost will approximate $62,000. These costs represent a five to six percent increase in the investment in the existing line. However, in both cases, the increased capital costs appear to be justified on economic grounds due mainly to the savings in lower applied film cost when compared to conventional solvent coatings. For the larger plant, the cost savings in the first year offset the capital cost entirely, while for the smaller plant the savings represent a return on investment approaching 20 percent.

Conversion to waterborne coatings, appears to be the most feasible option for dip coating lines. Switching to waterborne coatings would entail a capital investment of $3,000 for a smaller facility (seven million square feet/year) and $5,000 for a larger plant (22.5 million square feet/year). These costs represent an increase in investment of two to three percent. There is an increase in operating and maintenance costs due to higher materials costs, resulting in an increase in coating costs of seven percent for the smaller plant and four percent for the larger facility.

5.6.3 Economic Impact of Control Measures

An analysis of the economic impact of these costs on the segments of the metal furniture industry has not been conducted by EPA, thus no definitive conclusions can be drawn. However, it appears from the model plant analysis that conversion to high solids coatings for electrostatic spray lines is justified from an economic standpoint and would be of benefit to that portion of the industry utilizing this coating application method.

On the other hand, conversion to waterborne coating for dip coating lines is more difficult to assess since one has to consider both the capital investment requirements as well as the increased cost of coating on an annual basis. With regard to this latter point, the 1972 Census of Manufacturers indicates that the cost of coating materials comprise 0.8 to 1.4 percent of the value of shipments for metal furniture.[19] An increase of four to seven percent in coating costs resulting from the conversion to EDP will affect the final selling price for the metal furniture by an insignificant amount (less than 0.1 percent). In addition, a capital investment of $3,000 to $5,000 does not appear to be burdensome for most establishments. Some small, marginal facilities may find such an investment level unjustified, but the extent of this is not known.

5.7 REFERENCES FOR CHAPTER 5

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4. Energy and Environmental Analysis, p. 10.

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11. Pacific Environmental Services, Inc., Economic Analysis of Vapor Recovery Systems on Small Bulk Plants, September 1976, p. 2-2.

12. Motor Vehicle Manufacturers Association, Motor Vehicle Facts & Figures '77, pp. 8 and 9.

13. Springborn Laboratories, Inc., Study to Support New Source Performance Standards for Automobile and Light-duty Truck Coating, June 1977, EPA-450/3-77-020, p. 35.

14. Ibid, pp. 8-42 and 8-43.

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16. Springborn Laboratories, Inc., Study to Support New Source Performance Standards for Surface Coating of Metal Furniture, EPA-450/3-78-006, April 1978, p. 8-1.

17. Springborn, p. 8-15.

18. Environmental Protection Agency, Control of Volatile Organic Emissions from Existing Stationary Sources - Vol. III: Surface Coating of Metal Furniture, December 1977, pp. 3-8 and 3-9.

19. Springborn, p. 8-22.

APPENDICES

APPENDIX A

Ozone Design Values for 90 Air Quality Control Regions

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

DATE. MAY 24 1978

SUBJECT Ozone Design Values for 90 Air Quality Control Regions (AQCR's)

FROM Robert E. Neligan, Director
Monitoring and Data Analysis Division

TO Bruce Jordan
Environmental Protection Specialist, OAQPS

We have assembled ozone design values for 90 AQCR's based on the three year period 1975 - 1977. (See Table 1) This list updates previous lists which used 1974 and earlier data. Using three years of data the design value should fall between the third and fourth highest hourly averages based on the guidance for determining compliance with the statistical form of the ozone NAAQS. In selecting the enclosed design values we used the fourth highest hourly averages over the three year period, unless the difference between the third and fourth highest values exceeded .01 ppm (20 μg/m^3) in which case we took the average of the 3rd and 4th highest values.

Table 1 lists the following:

(1) the AQCR;
(2) the site which produced the old design value;
(3) the old design value (the 2nd maximum hour) in ppm based on the 1971 - 1976 time period;
(4) the year in which the value occurred;
(5) the site which measured the new design value;
(6) the new design value in ppm based on the 1975 - 1977;
(7) the year in which the new design value occurred.

The new design value is lower in 53 AQCR's than the old design value; higher in 19 AQCR's and 18 show no change. In the 19 AQCR's showing an increase in design values, 12 increased by .01 ppm, 6 by .02, and 1 by .03 ppm. In the 53 AQCR's showing a decrease in design values, 18 decreased by .01 ppm, 10 by .02 ppm, 10 by .03 ppm, 3 by .04 ppm, and 10 by .05 ppm or more. The largest decrease occurred in AQCR 106, Southeastern LA. - S.E. Texas, which had a design value of .32 ppm based on 1974 data. The design value has been revised to .18 ppm based on the 1975 - 1977 period.

Finally, compliance with several possible standards is summarized below:

	OLD STD.	EXPECTED VALUE STD		
	.08 ppm	.08	.10	.12
	2nd max	ppm	ppm	ppm
No. of AQCR's in Non-attainment	89	87	84	74

If you have any questions regarding this list, feel free to contact Robert B. Faoro, of my staff, at 541-5351.

Enclosure

cc: M. Jones, SASD
E. Lillis, MDAD
J. O'Connor, SASD
K. Lloyd, MDAD
W. Barber, OAQPS

TABLE 1. OZONE DESIGN VALUES FOR 90 NON-ATTAINMENT AIR QUALITY CONTROL REGIONS (AQCRs) BASED ON THE 1975-1977 TIME PERIOD

		OLD DESIGN VALUE BASED ON 2D MAX., 1971-1976			NEW DESIGN VALUE BASED ON THE 4TH HIGHEST VALUE, 1975-1977 ^{a}		
AQCR NUMBER	AQCR NAME	SITE	VALUE PPM	YEAR	SITE	VALUE PPM	YEAR
002	Columbus-Phoenix, GA	no data	.15 est	-	no data	.15 est	-
004	Metropolitan Birmingham	011300003 G01	.14	1975	same	.15	1977
005	Mobile-Pensacola, AL-FL	012380011 G01	.14	1974	103540004 F01	.16^{b}	1977
013	Clark-Mohave, AZ-NV	290320009 G01	.17	1973	290320001 G01	.15^{b}	1975
015	Phoenix-Tucson, AZ	030600006 G01	.18	1974	030600002 G01	.14	1977
016	Central Arkansas	Summer Study	.15	1977	041880002 P05	.13	1977
018	Metropolitan Memphis, AR-MS-TN	442340021 G01	.13	1975	same	.14	1976
022	Shreveport, LA	Summer Study	.14	1977	452180001 F03	.15	1977
024	Metropolitan Los Angeles	058440003 I01	.44	1974	same	.38	1976
025	North Central Coast, CA	054860001 I01	.12	1974	050275001 I01	.12	1976
028	Sacramento Valley, CA	056580003 F01	.18	1975	056600001 I01	.19	1975
029	San Diego, CA	055320003 I01	.27	1974	052460002 I01	.24	1976
030	San Francisco, CA	053140001 I01	.25	1974	same	.19	1975
031	San Joaquin Valley, CA	052820001 I01	.27	1974	052820001 I01	.19	1975
033	Southeast Desert, CA	050560001 I01	.26	1972	050560002 I01	.23	1976
036	Metropolitan Denver, CO	062210001 F01	.25	1974	060120002 F01	.17	1976
038	San Isabel, CO	060380004 F01	.10	1975	same	.09	1975
041	Eastern Connecticut	070200001 F03	.23	1975	070350123 F01	.23	1977
042	Hartford-New Haven-Springfield,CT-MA	070570003 F01	.32	1974	070700123 F01	.32^{b}	1977
043	New Jersey-New York-Connectiuct (NJ-NY-CT	070060123 F01	.26	1975	same	.27^{b}	1975
045	Metropolitan Philadelphia, N.J.-PA	391080012 F01	.32	1975	same	.30	1975
047	National Capital (DC-MD-VA)	211560001 F01	.23	1975	480080009 H01	.21^{b}	1976
048	Central Florida	104900002 F01	.10	1976	same	.10	1977
049	Jacksonville-Brunswick, (FL-GA)	101960048 H01	.19	1974	101960055 H01	.12	1975
050	Southeast Florida	104760001 G01	.14	1976	same	.13	1976
052	West Central Florida	103980012 H01	.18	1974	104360035 G02	.13^{b}	1975
055	Chattanooga,TN-GA	440380024 G01	.12	1975	same	.11	1976

TABLE 1. OZONE DESIGN VALUES FOR 90 NON-ATTAINMENT AIR QUALITY CONTROL REGIONS (AQCRs) BASED ON THE 1975-1977 TIME PERIOD

		OLD DESIGN VALUE BASED ON 2D MAX., 1971-1976			NEW DESIGN VALUE BASED ON THE 4TH HIGHEST VALUE, 1975-1977[a]		
AQCR NUMBER	AQCR NAME	SITE	VALUE PPM	YEAR	SITE	VALUE PPM	YEAR
056	Metropolitan Atlanta, GA	111600002 F01	.16	1975	same	.15	1975
060	State of Hawaii	120120001 F01	.08	1974	same	< .08	-
062	Eastern Washington-Northern Idaho	492040012 F01	.09	1975	same	< .08	-
065	Burlington-Keokut, IA	146080024 F01	.10	1976	same	.12	1977
067	Metropolitan Chicago, IL	141220025 H01	.23	1974	148020002 F01	.26	1977
069	Metropolitan Quad Cities, IL-IA	163280010 F05	.11	1975	146700002 F01	.13	1975
070	Metropolitan St. Louis, IL-MO	260200002 G01	.23	1975	264200061 H01	.23[b]	1975
073	Rockford-Janesville-Beloit, IL-WI	146680005 F01	.18	1975	361260001 G01	.17	1977
078	Metropolitan Louisville, KY	182380021 G01	.23	1975	same	.22[b]	1975
079	Metropolitan Cincinnati, KY-OH	362720006 H01	.21	1975	same	.20	1975
080	Metropolitan Indianapolis, IN	152040022 H01	.15	1976	152040033 H01	.17	1977
081	Northeast Indiana	no data	.17 est	-	-	.17 est	-
082	South Bend-Elkhart-Benton Harbor, IN-MI	no data	.16 est	-	-	.16 est	-
085	Metropolitan Omaha-Council Bluff, IA-NE	281880026 G01	.11	1975	same	.10	1976
092	South Central Iowa	161180037 G02	.10	1976	same	.11	1977
094	Metropolitan Kansas City, KS-MO	262380022 H01	.15	1975	same	.12	1975
099	South Central Kansas	173740011 F01	.29	1975	173740010 F01	.17	1975
106	Southern Louisiana-Southeast Texas	453830003 F01	.32	1973	same	.19	1976
113	Cumberland-Keyser,MD-WV	210800004 A05	.17	1974	same	.12	1976
115	Metropolitan Baltimore, MD	210680001 G01	.26	1975	same	.25	1976
118	Central Massachusetts	222640012 F01	.19	1976	same	.16	1976

TABLE 1. OZONE DESIGN VALUES FOR 90 NON-ATTAINMENT AIR QUALITY CONTROL REGIONS (AQCRs) BASED ON THE 1975-1977 TIME PERIOD

		OLD DESIGN VALUE BASED ON 2D MAX., 1971-1976			NEW DESIGN VALUE BASED ON THE 4TH HIGHEST VALUE, 1975-1977 [a]		
AQCR NUMBER	AQCR NAME	SITE	VALUE PPM	YEAR	SITE	VALUE PPM	YEAR
119	Metropolitan Boston, MA	222340003 F01	.20	1976	same	.17[b]	1976
120	Metropolitan Providence, MA-RI	220580004 F01	.20	1974	410140002 F03	.19[b]	1976
121	Merrimack Valley-Southern New Hampshire, MA-NH	222467001 F01	.20	1976	same	.17	1976
122	Central Michigan	231580011 H01	.19	1975	same	.17[b]	1975
123	Metropolitan Detroit-Port Huron, MI	231180020 G01	.26	1975	same	.23[b]	1976
124	Metropolitan Toldeo,MI-OH	336000006 H01	.15	1976	same	.14	1976
125	South Central Michigan	no data	.17 est	-	232840007 F01	.08	1977
128	Southeast Minnesota-La Crosse, MN-WI	243120019 G05	.17	1975	same	.16	1976
131	Minneapolis-St. Paul , MN	243300030 H01	.12	1975	same	.12	1975
151	Northeast Pennsylvania-Upper Delaware Valley, PA-NJ-DE	397620009 F01	.25	1974	390780017 F01	.23	1975
152	Albuquerque-Mid Riod Grande, NM	320040017 H02	.13	1976	320040015 H02	.14	1977
153	El Paso-Las Cruces-Alamogordo, NM-TX	451700028 F01	.16	1975	same	.16	1976
158	Central New York	336620005 F01	.11	1975	same	.12	1976
160	Genesse-Finger Lake, NY	2701-08 (State Code)	.13	1976	335760004 F01	.12	1976
161	Hudson Valley, NY	336020003 F01	.18	1973	333500002 F01	.14	1976
162	Niagara Frontier, NY	330130002 F01	.21	1975	same	.18[b]	1975
167	Charlotte, NC	340200011 G01	.16	1975	340700028 G01	.17[b]	1976
173	Dayton, OH	361660019 G01	.18	1976	same	.18	1977
174	Greater Metropolitan Cleveland, OH	361300034 H01	.17	1975	365320002 G02	.19[b]	1977
176	Metropolitan Columbus, OH	361460004 F01	.16	1976	same	.16	1976
178	Northwest Pennsylvania-Youngstown, OH-PA	367760007 I01	.21	1975	same	.21	1975
184	Central Oklahoma	372200033 F01	.14	1976	same	.12	1976
186	Northeastern Oklahoma	373000127 F02	.20	1976	same	.18	1976
193	Portland, OR-WA	381200001 F01	.15	1975	381580011 F01	.16	1977

TABLE 1. OZONE DESIGN VALUES FOR 90 NON-ATTAINMENT AIR QUALITY CONTROL REGIONS (AQCRs) BASED ON THE 1975-1977 TIME PERIOD

		OLD DESIGN VALUE BASED ON 2D MAX., 1971-1976			NEW DESIGN VALUE BASED ON THE 4TH HIGHEST VALUE, 1975-1977 a		
AQCR NUMBER	AQCR NAME	SITE	VALUE PPM	YEAR	SITE	VALUE PPM	YEAR
195	Central Pennsylvania	394460011 F01	.17	1975	same	.15	1975
196	South Central Pennsylvania	399560008 F01	.19	1975	same	.19	1975
197	Southwest Pennsylvania	391560005 F01	.21	1975	same	.20	1975
199	Charleston, SC	no data	.14 est	-	no data	.14 est	-
200	Columbia, SC	421900003 F01	.14	1974	same	.15	1977
208	Middle Tennessee	442540011 G01	.20	1975	443320007 F01	.17	1975
212	Austin-Waco, TX	450220012 F01	.14	1976	same	.13	.
214	Corpus Christi-Victoria,TX	451150001 P01	.15	1974	455340002 P05	.14	1977
215	Metropolitan Dallas-Fort Worth, TX	451310045 F01	.19	1974	same	.19	1977
216	Metropolitan Houston-Galveston, TX	452330024 F01	.30	1975	same	.27	1977
217	Metropolitan San Antonio,TX	454570036 F01	.18	1976	same	.16	1976
220	Wasatch Front, UT	460060001 F01	.17	1976	same	.16	1975
223	Hampton Roads, VA	481440004 F02	.18	1974	482060002 F01	.14	1977
225	State Capital, VA	481500010 F01	.18	1975	same	.20	1977
229	Puget Sound, WA	490960001 I01	.13	1974	490980010 F05	.14	1977
230	South Central Washington	492190003 F01	.15	1974	no data	.15	1974
239	Southeastern Wisconsin	512200041 F01	.26	1976	same	.25	1976
240	Southern Wisconsin	510600001 F03	.13	1976	510600005 F02	.13	1977

[a] The fourth highest hourly average over the 3-year period, 1975-1977, was used unless the difference between the third and fourth highest values exceeded .01 ppm (20 μg/m^3) in which case the average of the 3rd and 4th highest values was used.

[b] These values represent the average of the 3rd and 4th highest values.

APPENDIX B

Mobile Source Emission Factors

APPENDIX B

MOBILE SOURCE EMISSION FACTORS

This appendix summarizes the mobile source emission factors which serve as the basis for emission projections resulting from the Federal Motor Vehicle Control Program as well as an inspection/maintenance program. Table B-1 presents the non-methane hydrocarbon (NMHC) emission factors for various classes of vehicles for base years 1975 and 1987. The 1987 emission factors reflect the emission standards mandated by the Clean Air Act Amendments of 1977.

In order to estimate the change in mobile source emissions for an area between 1975 and 1987, the following equation is used:

$$\text{1987 Emissions} = \text{1975 Emissions} \times \frac{\text{1987 Emission Factor}}{\text{1975 Emission Factor}} \times (1 + \text{Annual Growth Rate})^{12}$$

Estimates have also been made regarding the effectiveness of an inspection/maintenance program in reducing mobile source emissions through overall improvement in fleet maintenance. Emission factors for light duty vehicles for various I/M scenarios are summarized in Table B-2. As can be seen, the effectiveness of an I/M program depends on the stringency level and the extent of mechanic training. For a 30 to 40 percent stringency level, an I/M program can reduce emissions in 1987 by 25 to 44 percent depending on whether there is mechanic training. For purposes of this study, an emission reduction of 30 percent was assumed to reflect a mid-range of the estimates.

Table B-1. NON-METHANE HYDROCARBON EMISSION FACTORS FOR MOBILE SOURCES[a] (grams/mile)

	1975	1987
Light Duty Vehicles (without I/M)	8.27	2.24
Light Duty Trucks		
0-6000 lbs	8.98	3.71
6000-8500 lbs	12.22	4.99
Heavy Duty Gasoline Trucks	29.99	14.28
Heavy Duty Diesel Trucks	4.42	3.41
Motorcycles	12.07	1.40

[a] Includes evaporative emissions

Source: Environmental Protection Agency, Office of Transportation and Land Use Policy, Mobile Source Emission Factors, EPA-400/9-78-005, March 1978.

Table B-2. EFFECTIVENESS OF INSPECTION/MAINTENANCE PROGRAMS
FOR LIGHT-DUTY VEHICLES (1987 NMHC Emission Factors)

		30% Stringency Level*		40% Stringency Level*	
	Base (w/o I/M)	No Mechanic Training	Mechanic Training	No Mechanic Training	Mechanic Training
Grams/Mile	2.24	1.68	1.33	1.60	1.26
% Reduction from Base	--	25%	41%	29%	44%

*Stringency level is a measure of the rigor of a program based on the estimated fraction of the vehicle population whose emissions would exceed cutpoints for NMHC were no improvements in maintenance habits or quality of maintenance to take place as a result of the program.

Source: Based on Appendix N to 40 CFR Part 51: Emission Reductions Achievable Through Inspection and Maintenance of Light Duty Vehicles, Motorcycles, and Light and Heavy Duty Trucks, May 1977.

APPENDIX C

Analysis of Costs for Hydrocarbon Control Measures

Appendix C

ANALYSIS OF COSTS FOR HYDROCARBON CONTROL MEASURES

C.1. Introduction

This analysis presents the costs for selected hydrocarbon control measures for stationary and mobile sources. The costs are derived from numerous EPA reports and documents and represents the Agency's best estimates of costs as of July, 1977. The sources covered by this analysis are not the only sources of volatile organic emissions, rather they are the sources for which cost information is readily available. Some are described more completely than others, with the extent of coverage depending on the availability of information for each source.

C.2. Costs for Stationary Source Control Measures

Tables C-1 through C-7 summarize the control costs for selected stationary sources. The methodology for estimating costs for most sources involved selecting model facilities of a size or sizes considered typical in the industry. For these model facilities, capital costs for the control equipment were developed which included equipment costs as well as installation costs.

The annualized costs for each model facility include direct operating costs such as labor and materials, maintenance costs, and annualized capital charges. This latter component accounts for depreciation, interest, administrative overhead, property taxes, and insurance. The depreciation and interest are computed by use of a capital recovery factor, the value of which depends on the operating life of the device and the interest rate (in most cases, an annual interest rate of 10 percent has been assumed).

In many instances, the annualized costs also include a credit for product, heat or steam recovery. These credits are substracted from the costs of control so that the annualized costs included in the tables are net costs.

The cost effectiveness of control represents the net annualized costs divided by the annual tons of hydrocarbons removed. While cost effectiveness serves a useful purpose as one factor in comparing control measures, it cannot serve as the only decision-making tool. Cost effectiveness in itself does not give any indication of the economic feasibility of alternatives since it does not take into account the baseline economic or financial conditions of the source or industry. However, such an evaluation was beyond the scope of this study, so that cost effectiveness is the only means available by which to compare control measures. Nonetheless, the limitations should be recognized.

Finally, there are in many cases several control measures available to achieve a certain level of control at the various sources. However, this study considers costs for only one control measure at each control level. In choosing the measure, the assumption is made that a prudent plant manager will choose the lowest cost option on an annualized cost basis. In addition, if a higher level of control can be achieved at a lower annualized cost than a lower level of control, then the latter is not considered to be a viable option. Thus some of the control measures considered may not be as energy efficient as others or recover the end product, but they are still the least cost options and have therefore been chosen for inclusion in the tables.

C.2.1. Oil and Gas Production, Refining, and Storage

Table C-1 presents costs of controlling hydrocarbon emissions from selected sources associated with oil and gas production, petroleum refining, petroleum storage tanks, and natural gas and gasoline processing plants. Exact cost figures are not yet available for these sources, but preliminary consideration of costs indicates that the net costs will be minimal since the costs of control will be, for the most part, offset by appreciable savings from product recovery In fact, much of the control equipment is already in operation in many plants or fields, indicating that the controls must be justifiable from a cost standpoint in many cases.

C.2.2 Gasoline Handling and Distribution Operations

The costs for controlling hydrocarbon vapor emissions from selected gasoline handling and distribution operations are shown in Table C-2. These operations trace the flow of gasoline and resultant hydrocarbon vapors from the bulk terminal to the bulk plant to the service stations and finally to the refueling of vehicles. As can be seen from the table, relative control costs are much higher at smaller facilities as evidenced by the significantly greater cost effectiveness numbers.

At service stations there are two sources of vapor loss--the underground tanks (Stage I) and vehicle refueling (Stage II). Stage I can br implemented alone at service stations but Stage II cannot since vapors captured during refueling would be lost through the underground tanks that had no control. Thus, costs are presented for Stage I alone and Stages I and II in conjunction. The cost effectiveness numbers for Stages I and II take into account the total amount of vapors collected during the two stages instead of just the incremental cost of controlling Stage II emissions.

C.2.3. Surface Coating Operations

Table C-3 summarizes the costs for controlling volatile organic emissions from selected surface coating operations. Except for the primer application area and curing oven in automobile and light duty truck assembly plants, which utilize a process change in applying the primer, the control measures considered for these sources are add-on technology to destroy or recover organic compounds from exhaust gases. Thermal incineration, which destroys organic emissions, is considered for all of these processes instead of catalytic incineration because of the variability in the use of the latter. Catalytic incineration is limited to a more restricted range of applications as a result of problems with catalyst deactivation, coating with particulates, poisoning, and type of fuel used (ref. 12, pp. 54-55). Where applicable, though, catalytic units offer the potential of significantly lower fuel consumption and smaller, lighter-weight units. However, it was beyond the scope of this study to judge the effectiveness of the option in all of the processes considered, so thermal incineration was used since its use is not as limited, even though the costs may be higher.

Costs for incineration include savings from the use of primary heat recovery. Primary heat recovery involves the use of incinerator exhaust to preheat incinerator inlet air instead of using expensive auxiliary fuel. Further heat recovery, called secondary heat recovery, is possible in some applications where incinerator exhaust from the primary heat recovery stage (or from the incinerator directly if there is no primary heat recovery) replaces energy usage elsewhere in the plant. This energy can be used for process heat requirements or for plant heating. However, credits for secondary heat recovery have not been included in this analysis since the amount of energy that a plant can recover and use depends on the individual circumstances of the plant (ref. 12, p. 45).

Carbon adsorption, the other add-on technology considered, separates and recovers organic vapors from the exhaust stream but is not as efficient as incineration in general. The annualized costs for this control measure includes a credit for the recovered solvent at its fuel value, which is lower than the solvent's market value. Nonetheless, the market value of the recovered solvent has not been used in general because reuse of the solvent may not be feasible due to mixture of solvents or breakdown of single solvents. Distillation is possible, but the complexity and cost are so variable that it is difficult to generalize (ref. 12, p. 32). Thus, the fuel value of the solvent has been used as a conservative figure.

C.2.4. Graphic Arts Processes

Costs of control measures for selected graphic arts processes are tabulated in Table C-4. Once again, the techniques considered are incineration with primary heat recovery and carbon adsorption with solvent recovery credited at the fuel value of the solvent.

C.2.5. Degreasing, Dry Cleaning, and Cutback Asphalt Paving

Table C-5 presents control costs for selected sources of evaporative emissions of organic vapors. One such category of sources is organic solvent metal cleaning, which includes cold cleaners, open top vapor degreasers, and conveyorized degreasers. Dry cleaning operations include neighborhood and industrial petroleum solvent plants as well as coin-op, commercial, and industrial perchloroethylene solvent plants. Finally, the control measure for cutback asphalt paving entails the substitution of emulsified asphalt in order to eliminate evaporative emissions.

C.2.6. Rubber Products Manufacture

In Table C-6 costs are summarized for selected processes in the manufacture of various rubber products. The manufacture of tires and inner tubes represents the largest source of emissions in this category with over 50 percent of the total. Thermal incineration and carbon adsorption are the primary control measures for most sources. However, for the sole attachment operation in shoe manufacturing, substitution of hot melt adhesives accomplishes the control of emissions at a lower cost than the add-on technologies.

C.2.7. Chemical Manufacturing Processes

Table C-7 indicates the costs for controlling hydrocarbon emissions from selected chemical manufacturing processes. For all but one process, two sets of costs and control measures are given for each level of control efficiency. The difference depends on whether or not the heat from the control device is recovered and utilized. If heat is recovered, equipment has to be added to utilize the heat for process requirements or to generate steam for process requirements. For this option to be feasible, the higher capital costs have to be offset by the savings for the heat or steam recovery. This means that the plant has to have uses for the recovered heat or steam either for in-plant uses or for other plants nearby. Thus, the special circumstances of individual plants dictate the viability of heat or steam recovery. Existing plants may not have the flexibility necessary to incorporate this option. As a result, some plants may have to employ incineration without any heat or steam recovery, making the annualized costs of control higher than would otherwise be the case.

C.3. Mobile Source Control Measures

While the Federal Motor Vehicle Control Program is intended to reduce tailpipe hydrocarbon emissions from new vehicles, transportation control measures are designed to reduce emissions from in-use vehicles. Such measures can be divided into classes of measures that reduce in-use automobile emission rates (emissions per mile) and classes of measures that reduce vehicle miles traveled (VMT). The former class includes essentially inspection/maintenance (I/M) as the only reasonably available measure, while the latter class includes transit improvements, carpooling, and restrictions on the use of automobiles. In most transportation control plans, emphasis has been placed on I/M with VMT reduction measures used where in-use controls are not sufficient.

C.3.1. Inspection/Maintenance

Motor vehicle inspection and maintenance (I/M) is a program of periodic inspection of vehicles to determine the levels of emissions from the vehicles. Those vehicles found to emit excessive amounts of pollutants are failed, and must then be repaired and reinspected.

Reasonable estimates can be made of the costs and cost effectiveness of an I/M program since data can be developed for each serviced vehicle on inspection costs, maintenance costs, fuel savings, and emission reduction. The cost of building an inspection station varies depending on the size of the station, the cost of land, and the type of test run. For a two-lane centralized public facility utilizing the idle test, the capital cost of the station ranges from $117,000 to $237,000. For a loaded test, where the vehicle is run under simulated driving conditions on a dynomometer, the capital cost is estimated to be $140,000 to $260,000 (ref. 13, p. III-C-8).

The inspection costs can vary depending upon who operates the program, the complexity of required equipment, and whether safety testing is included in the inspection. Costs can be as little as $0.30 per vehicle if an idle test is combined with an established inspection program. On the other extreme, one state which has built a loaded test system from scratch requires an inspection fee of $5.00 to cover costs.

The maintenance costs per serviced vehicle depend on the percentage of vehicles which fail the test. A lower failure rate means the maintenance cost per serviced vehicle will be higher since only the worst emitters with more severe problems will be rejected. Naturally, the cost of servicing these vehicles is higher than the cost of servicing vehicles with less severe problems. For a loaded test, the maintenance cost per serviced vehicle is estimated to range from $36 for a 10 percent failure rate to $26 for a 50 percent failure rate. Of course, more vehicles will be affected by a high failure rate, making the total cost of maintenance for all vehicles higher (ref. 13, p. III-C-10).

By serving as a check to insure that vehicles are maintained properly throughout their lifetime, an I/M program can result in significant fuel savings by motor vehicles. Once again, the dollar savings per serviced vehicle depend on the failure rate, with the savings varying inversely with the failure rate. Estimated annual fuel savings per serviced vehicle range from $21 at a 50 percent failure rate to $49 at a 10 percent failure rate (ref. 13, p. III-C-11).

At failure rates of 30 percent or less, maintenance costs are offset by fuel savings. Hence, the average out-of-pocket costs of an I/M program will be limited to the inspection fee, which will be about $5 per vehicle (ref. 14, p. 21). Based on this result and estimates of current I/M effectiveness in reducing hydrocarbon emissions, the cost effectiveness of I/M is estimated to be $340 per ton of hydrocarbons removed (ref. 14, p. 22). As the emissions of new cars are reduced through statutory requirements, though, the cost per ton will increase, possibly to about $550 per ton by 1985.

C.3.2. VMT Reduction Measures

Most VMT reduction measures are interrelated and require a coordinated program in order to be an effective means for reducing hydrocarbon emissions. The maximum emissions reductions from transportations measures will result from coordinated measures designed to discourage low occupancy auto use and to encourage transit and carpool use. The following discussion outlines each group of measures and indicates the range of costs associated with some of the measures.

C.3.2.1. Ridesharing

Carpools are an effective means of reducing commuter VMT. With four members in a carpool, VMT can be reduced 75 percent over the VMT if each rider drove separately.

The riders can also experience sizeable savings in travel costs. For a four-person carpool with a 20 mile round-trip, one report estimates that each rider will experience annual savings of $475. This savings increases to $925 for a 40 mile round trip (ref. 15, p. 81).

The primary costs associated with carpooling are promotional costs. However, an areawide computerized carpool matching service can be operated for about $4 per participant (ref. 15, p. 80).

C.3.2.2 Preferential Treatment of High-Occupancy Vechiles

Dedicating lanes on freeways and city streets for the exclusive use of buses and carpools during peak travel periods permits these vehicles to bypass congested sections of roadways. This increases the attractiveness of high-occupancy travel modes since the passenger's travel time is substantially reduced.

Techniques used to give preferential treatment to these vehicles vary from exclusive lanes on freeways to curb bus lanes on city streets that require only remarking the lines. Costs vary widely depending on the complexity of the improvements. For example, an exclusive busway in California cost $4.9 million per mile to construct, while curb lanes on city streets can cost $3,000 per mile to make the necessary changes (ref. 15, pp. 31 and 38).

C.3.2.3. Transit Service Improvements

A number of aspects of transit operations can be improved to enhance the level of service. These include transit marketing, security measures, transit shelters, transit terminals, and transit fare policies and fare collection techniques (ref. 15, p. 107). Since these measures are solely dependent on local conditions, no attempt is made to assess costs.

C.3.2.4. Parking Management

EPA considers parking restrictions, when coupled with transit and carpool incentives, to be an effective and necessary means for standards attainment and maintenance (ref. 16, p. 15). Parking management policies relating to (1) the location of parking, (2) the amount of on- and off-street space allocated to parking, (3) the parking charges applied to the allocated space, and (4) the length of time parking is permitted all can have a dramatic effect on traffic flow and VMT.

One means to discourage parking is through the use of taxes or surcharges to increase parking cost. Studies have predicted that an increase in daily parking cost up to one dollar can result in a reduction of three to 15 percent in VMT in the central business district while increasing transit use (ref. 15, p. 64).

Another parking management measure is the use of park-and-ride lots. Coupling fringe or corridor parking facilities with express transit service to activity centers can contribute significantly to the success of parking policies designed to reduce the number of CBD-directed automobiles. The estimated cost of a surface level, self-park fringe parking lot ranges from $0.50 to $2.00 per vehicle per day (ref. 15, p. 70).

Table 1. COSTS OFCONTROL MEASURES FOR OIL AND GAS PRODUCTION, REFINING, AND STORAGE

Source/Affected Operation	Facility Size	Control Efficiency %	Capital Cost ($000)	Annualized Cost ($000)	Cost Effectiveness[1] ($/ton)	Control Measure	Reference
1. Oil and gas production		NA[2]	NA	NA	Min[3]	Detection and maintenance	1, p. 30
2. Petroleum Refineries Miscellaneous Sources		91	NA	NA	Min[3]	- Detection and maintenance - Mechanical Seals - Flare Header System	1, p. 17-18
-Process drain and wastewater separators	62,000 bbl/day	90	NA	NA	(64)[4]	- Floating roof covers	1, p. 20
	200,000 bbl/day	90	NA	NA	(73)	- Floating roof covers - Detection and maintenance	
-Vacuum producing systems	100,000 bbl/day	99	NA	NA	(28)[5]	- Incineration of non-condensables	1, p. 22
-Process unit turnaround		97	NA	NA	Min[3]	- Combust non-condensable vapors	1, p. 25
3. Storage of crude oil and gasoline	250,000 bbl.	97	9.8	2.0[6]	200	- Secondary seal on floating roof tank	1, p. 2
4. Natural gas and natural gasoline processing plants		91	NA	NA	Min[3]	- Covers for oil-water separators - Mechanical seals - Detection and maintenance	1, p. 27

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[1] Costs include credit for product recovery, parentheses indicate net savings.

[2] N.A. = not available.

[3] Exact costs for these control measures are not known. However, it is believed that costs are minimal since much of the control equipment is already in operation in many plants or fields. In addition, it is believed that control costs will be offset by savings from product recovery.

[4] These savings pertain only to floating roof covers.

[5] This estimate does not include cost of a condensate receiver for a surface condenser or the cost of covering the barometric hot well.

[6] Emission reduction and hence product recovery and cost-effectiveness of secondary seals over and above primary seals will vary with the wind velocity and the true vapor pressure of the stored product.

Table 2. COSTS OF CONTROL MEASURES FOR SELECTED GASOLINE HANDLING AND DISTRIBUTION OPERATIONS

Source/Affected Operation	Facility Size	Control Efficiency %	Capital Cost ($000)	Annualized Cost[1] ($000)	Cost Effectiveness[1] ($/ton)	Control Measure	Reference
1. Marine Terminals	10^7 bbl/day	95	4000	925	4000	Refrigeration/ absorption	2, p. 142
2. Gasoline Bulk Terminals							
- Top Splash Fill	250,000 gpd	94	195	(8 5)	(24)	Refrigeration	3, p. 4-4
	500,000 gpd	94	281	(38 8)	(55)	Refrigeration	
- Top Submerged Fill and Bottom Fill	250,000 gpd	87	176	19.9	146	Refrigeration	
	500,000 gpd	87	264	22.0	80	Refrigeration	
3. Gasoline Bulk Plants							
- Top Splash Fill	5,000 gpd	58	0.3	(0.7)	(120)	Conversion to top-submerged fill	4, p. 4-3
		93	24 8	5 8	350	Vapor Balance	
	20,000 gpd	58	0 6	(2.9)	(120)	Conversion to top-submerged fill	
		93	57.0	13 3	200	Vapor balance	
- Top-submerged Fill and Bottom Fill	5,000 gpd	93	24 8	5.8	350	Vapor balance	
	20,000 gpd	93	57.0	1.3	200	Vapor balance	
4. Service Stations							
- Underground tanks (Stage I)	3 tanks	93	0.6	(0.2)	(110)	Vapor balance	5
- Underground tanks and vehicle refueling (Stages I and II)	20,000 gpm 3 pumps	90	4 4	0.7	375	Vapor Collection System[3,4]	5
	60,000 gpm 9 pumps	90	8 8	1.5	260		
	120,000 gpm 12 pumps	90	10 9	1.3	120		
5. Gasoline tank trucks		99	N.A[5]	N.A.	Min.[6]		1, p. 15

[1] Costs include credit for product recovery. Parentheses indicate net savings.

[2] Based on 15 year life and 10% interest for capital recovery factor.

[3] Three technologies (no latch/no flow balance, hybrid aspirator assist, and vacuum assist) appear capable of achieving greater than 90 percent control While the control capabilities of the three systems are not significantly different under most conditions, costs have been indicated for the hybrid system since these costs range between the costs for the other two systems.

[4] Underground tanks controlled with vapor balance system

[5] N.A. - not available

[6] The cost of control will be limited to the cost of installing and maintaining effective seals, connections, and pressure-vacuum valves. This cost is considered minimal when compared to the value of the product recovered

Table 4. COSTS OF CONTROL MEASURES FOR SELECTED GRAPHIC ARTS PROCESSES

Source/Affected Operation	Facility Size	Control Efficiency %	Capital Cost ($000)	Annualized Cost[1] ($000)	Cost Effectiveness ($/ton)	Control Measure	Reference
1 Webb Offset Printing	5000 scfm	95	120 0	70 0[2]	210	Direct Flame incinerator	1, p. 45
		90	170 0	35.0[3]	240	Carbon adsorption	
	20,000 scfm	95	160.0	35.0[2]	110	Direct flame incinerator	
		90	340 0	110.0[3]	100	Carbon adsorption	
2 Flexographic Printing	5000 scfm	95	120.0	70.0[2]	210	Direct flame incinerator	1, p. 52
	20,000 scfm	95	160.0	35.0[3]	110	Direct flame incinerator	
3 Rotogravure printing	5000 scfm	95	120.0	70 0[2]	210	D.F. incinerator	1, p. 43
		90	170 0	35 0[3]	240	Carbon adsorption	
	20,000 scfm	95	160 0	35.0[2]	110	D.F. incinerator	
		90	340 0	110 0[3]	100	Carbon adsorption	
4 Webb Letterpress printing	5000 scfm	95	120 0	70 0[2]	210	D F. incinerator	1, p. 48
		90	170 0	35.0[3]	240	Carbon adsorption	
	20,000 scfm	95	160.0	35 0[2]	110	D.F. incinerator	
		90	340 0	110 0[3]	100	Carbon adsorption	

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[1] Costs include credit for product or heat recovery. Parentheses indicate net savings.

[2] Includes credit for primary heat recovery.

[3] Includes solvent recovery credited as fuel value of solvent.

Table 5. COSTS OF CONTROL MEASURES FOR SELECTED SOURCES OF EVAPORATIVE HYDROCARBON EMISSIONS

Source/Affected Operation	Facility Size	Control Efficiency %	Capital Cost ($000)	Annualized Cost ($000)	Cost Effectiveness ($/ton)	Control Measure	Reference
1. Organic solvent metal cleaning operations							
- Cold Cleaners Low volatility solvent		15%	25	0.5	20	Drainage facility	7, p. 4-7
High volatility solvent		30%	65	(26)	(245)	Drainage facility with mechanically assisted cover.	
- Open top vapor degreasers	Typical	30 45 97	0.3 6.5 16.0	(800) 84 36	(365) 25 1	Manual cover Refrigerated chiller Enclosed design	7, p. 4-14
- Conveyorized degreasers	Typical						
Monorail		50	8.5	(3735)	(260)	Refrigerated chiller	7, p. 4-17
Cross-Rod		50	7.5	(650)	(110)	Refrigerated chiller	
2. Dry cleaning Operations							
- Petroleum plants							
•Neighborhood cleaners dryer, still, misc.		80	16.8	3.5	735	Carbon adsorption	8, p. 48
Filter Muck		90	5.0	1.0	700	Centrifugal separator	
TOTAL			21.8	4.5	730		
•Industrial plant							
Dryer, Still, Misc.		80	71.2	4.4	55	Carbon adsorption	8, p. 4-10
Filter Muck		90	5.2	(3.1)	(127)	Centrifugal separator	
TOTAL			76.4	1.3	15		
- Perchloroethylene plants							
•Coin-op facility		66	7.3	1.8	5450	Carbon adsorption	8, p. 4-18
•Commercial plant		55	2.9	0.1	55	Carbon adsorption	
•Industrial plant		51	7.5	(9.4)	(345)	Carbon adsorption	
3. Cutback asphalt paving		99	N.A.	N.A.	Min.	Substitution of emulsified asphalt	1, p. 32

[1] Costs include credit for product or heat recovery. Parentheses indicate net savings.

[2] The price difference between the two types of liquified asphalt concrete is insignificant.

Table 6. COSTS OF CONTROL MEASURES FOR RUBBER PRODUCT MANUFACTURE

Source/Affected Operation	Facility Size	Control Efficiency %	Capital Cost ($000)	Annualized Cost[1] ($000)	Cost Effectiveness ($/ton)	Control Measure	Reference
1. Synthetic Elastomers							
- Tank Farm	20,000 gal	80	18.0	3.6		Floating covers	9, p. 4.1.3
- Recovery area	1,000 scfm	90	70.0	27.0[3]	160	Adsorption	9, p. 4.4.3
- Finishing area	15,000 scfm	90	150.0	65.0[2]	35	Thermal incineration	9, p. 4.6.4
2. Fires and Inner Tubes							
- Fabric cementing	5,000 scfm	80 90	180.0 120.0	38.0[3] 35.0[2]	90 65	Adsorption Incineration	9, p. 4.14.3
- Green tire spraying	15,000 scfm	80	320.0	50.0[3]	35	Adsorption	9, p. 4.13.3 (Table 12)
		90	150.0	70.0[2]	45	Thermal incineration	
- Curing operations	25,000 scfm	90	270.0	280.0	2900	Thermal incineration	9, p. 4.10.3
- Undertread cementing	5,000 scfm	90	120.0	40.0[2]	75	Incineration	9, 4.12.2
3. Rubber Footwear							
- Rubber Cementing (Adhesive spraying)	1,000 scfm	90	70.0	19.0[3]	.220[3]	Adsorption	9, p. 4.16.2
- Molding operations	25,000 scfm	90	270.0	280.0[2]	2900[4]	Thermal incineration	9, p. 4.10.3 (Table 9)
4. Reclamatory processes	1,500 scfm	90	175.0	56.8	N.A.	Absorption: condenser and scrubber	9, p. 4.19.2
5. Rubber Hose and Belting							
- Fabric Cementing	5,000 scfm	90	120.0	35.0[2]	65	Thermal incineration	9, p. 4.14.3
6. Fabricated Rubber Goods							
- Molding	25,000 scfm	90	270.0	280.0[2]	2900	Thermal incineration	9, p. 4.10.3
- Curing	25,000 scfm	90	270.0	280.0[2]	2900	Thermal incineration	9, p. 4.10.3
- Adhesive spraying	1,000 scfm	90	70.0[3]	19.0[3]	220	Adsorption	9, p. 4.16.2
7. Gaskets, Packing, Sealing							
- Molding	25,000 scfm	90	270.0	280 0[2]	2900	Thermal incineration	9, p. 4.10.3
- Adhesive spraying	1,000 scfm	90	70.0	19.0[3]	220	Adsorption	9, p. 4.12.2
8. Nonferrous Wiredrawing							
- Curing	25,000 scfm	90	270.0	280.0[2]	2900	Thermal incineration	9, p. 4.10.3
9. Tire Retreading							
- Rubber cementing	1,000 scfm	90	70.0	19 0[3]	220	Adsorption	9, p. 4.16.2
- Curing	25,000 scfm	90	270.0	280.0[2]	2900	Thermal incineration	9, p. 4.10.3
10. Shoe Manufacturing							
- Sole attachment operation	1500 pr. shoes per day	90	5.3	1.2	220	Hot melt adhesives	10, p. 6
	4500 pr. shoes per day	90	15.9	4.0	235	Hot melt adhesives	10, p. 8
	10,500 pr shoes per day	90	37.0	10 6	275	Hot melt adhesives	10, p. 10

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[1] Costs include credit for product or heat recovery. Parentheses indicate net savings.

[2] Includes credit for primary heat recovery

Table 7. COSTS OF CONTROL MEASURES FOR SELECTED CHEMICAL MANUFACTURING PROCESSES

Source/Affected Operation	Facility Size	Control Efficiency %	Capital Cost ($000)	Annualized Cost ($000)	Cost Effectiveness ($/ton)	Control Measure	Reference
1. Ethylene Dichloride (oxychlorination)	350 x 10^3 TPY	97	2050	207^3	20	Thermal incinerator, waste boiler and caustic scrubbing	11, Vol. 3 pp. ED-39-4
		97	1500	1075^4	115	Thermal incinerator and caustic scrubbing	
2. Acrylonitrile	100 x 10^3 TPY	99	1515	190^3	20	Thermal incinerator and waste heat boiler	11, Vol. 2, pp. AN-32
		99	700	470^4	45	Thermal incinerator	14
3. Ethylene Oxide							
- Air oxidation plant	100 x 10^3 TPY	85	485	38^5	20	Catalytic incineration	11, Vol. 6, pp. EO-31-3
- Oxygen oxidation plant	100 x 10^3 TPY	85	45	$(11)^3$	(5)	Steam generator	
		85	30	24^4	15	Thermal incineration	
4. Formaldehyde							
- Silver catalyst	50 x 10^3 TPY	80	88	$(44)^6$	(275)	Boiler house vent gas burner	11, Vol. 4, p. FS-33
		80	92	22^4	140	Thermal incinerator	
- Mixed oxide catalyst[7]	50 x 10^3 TPY	93	135	105^3	155	Thermal incinerator	11, Vol. 5, p. FM-25
		93	108	150^4	220	Thermal incinerator	

[1] Costs include credit for product or heat recovery. Parentheses indicate net savings.

[2] Costs are updated to 1976 values from reference 11.

[3] Includes credit for steam or heat recovery.

[4] Does not include credit for steam or heat.

[5] Includes heating value credit.

[6] Includes credit for heat recovery as process utilizes waste gas as fuel supplement.

[7] Does not include recycling.

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