Technical Support Report for Regulatory Action

Regional Air Quality Impact of Motorcycles

August, 1975

Notice

Technical support reports for regulatory action do not necessarily represent the final EPA decision on regulatory issues. They are intended to present a technical analysis of an issue and conclusions and/or recommendations resulting from the assumptions and constraints of that analysis. Agency policy constraints or data received subsequent to the date of release of this report may alter the conclusions reached. Readers are cautioned to seek the latest analysis from EPA before using the information contained herein.

Emission Control Technology Division
Office of Mobile Source Air Pollution Control
Office of Air and Waste Management
U.S. Environmental Protection Agency

Abstract

The hydrocarbon, carbon monoxide, and oxide of nitrogen emission contributions of motorcycles are compared with the emission contributions of light duty vehicles, light duty trucks, and heavy duty vehicles nationwide and for six different air quality control regions (AQCRs). The AQCRs were selected as representative of those regions having trouble meeting national ambient air quality oxident and/or carbon monoxide standards. The analysis indicated that uncontrolled motorcycles alone are a relatively small percentage of the present total mobile source emissions in all AQCRs emissions. However, uncontrolled motorcycles do represent a significant percentage of the maximum allowable emissions in the AQCRs assessed. As controls of other mobile sources (namely light duty vehicles) become effective, the motorcycles if left uncontrolled would make a significant contribution to the air pollution problem. This holds true in each of the six AQCRs examined in this report and is especially significant at high altitudes.

John Rothhaar
Prepared by

Marcia Williams
Prepared by

William Houtman
Project Manager
Motorcycle Regulations

John P. DeKany
Division Director
Emission Control
Technology Division

Distribution:

D. Alexander
E. Brune
T. Cackette
J. P. DeKany
C. L. Gray
D. Hardin
K. Hellman
W. Houtman
T. Huls
R. Jenkins
G. Kittredge
E. Rosenberg
J. Rothhaar
R. Stahman
E. O. Stork
G. Thompson
M. Williams
G. Forbes

Statement of Problem

Before a new or revised regulation package is proposed, three questions need to be carefully considered. First, the source addressed in the regulation of interest needs to be evaluated to determine whether it contributes a significant amount of emissions to the total emission inventory. Second, the improvement in air quality as a result of the proposed action must be evaluated. The air quality improvement must be considered relative to air quality improvements which can be obtained through alternative control strategies. Third, the cost of obtaining the air quality improvement must be computed and compared with alternative strategy costs on a cost per weight of pollutant removed basis.

The EPA Environmental Impact Statement (EIS) for motorcycles has considered each of these questions. However, most analyses to date have focused on only two geographic scenarios, nationwide and the LA AQCR. The national emission inventory case has been examined in detail. This case is useful in gaining a general perspective of the problem. However, the national case contains data from regions which have no problem meeting ambient air quality standards as well as regions which are borderline cases and those that are quite far away from achieving the desired ambient air quality levels. Therefore, regional examination of the air quality implications of a strategy are necessary in order to evaluate the potential strategy benefits where control is most needed.

The intent of this paper is to assess the extent of the motorcycle contribution to the total mobile source emission inventory in a range of AQCRs which do not currently meet the National Ambient Air Quality Standards and which are expected to continue to have trouble meeting the NAAQSs in the 1975-1990 time frame. The regions selected are: Salt Lake City, Houston, Phoenix/Tuscon, Denver, Los Angeles and New Jersey. The national case is included for comparison. All cases are based on the most up-to-date input data.

This paper does not extend the analysis to address the tons of improvement and cost effectiveness of motorcycle control versus alternative control strategies on a region by region basis. Although such an extension would be useful and will be performed in the future for selected regions, as a first cut approximation, the national figures for cost effectiveness and quality of control which can be achieved are not expected to change the ranked order of various control strategies. (This national analysis exists in the present EIS.) The purpose of this analysis is limited to an assessment of the regional air quality impact of motorcycles.

Discussion

The methodology used to compute vehicle emissions from a given source in a given calendar year is stated in the following equation,

$$\text{Emissions (tons)} = \left(\sum_{i=1}^{12} e_i \, m_i\right) c$$

where,

e_i is the emissions (gm/mile) in the calendar year of interest by vehicles that are i years old.

m_i is the mileage in the calendar year of interest by vehicles that are i years old (miles per vehicle times number of vehicles),

c is a conversion factor to convert total grams to total tons.

By computing emissions in tons for each mobile source for each calendar year, the percent of total mobile source emissions attributed to individual sources can be assessed.

Appendix I gives a detailed description of where the input data on emission rates by model year and age, vehicle mix by age, mileage accumulation by age, and vehicle miles travelled including growth rate estimates were obtained for each mobile source and each of the geographic regions.

Tables 1 to 7 present the percentage impact of motorcycles to the total mobile source HC and CO inventory as a function of calendar year for each of the geographic regions. The HC inventory includes the crankcase and evaporative HC emissions from LDVs, LDTs, and HDVs. No evaporative or crankcase emissions are included for motorcycles since motorcycle evaporative and crankcase emissions have not been well characterized.* The tables are based on the assumption that the following

*Limited engineering estimates performed by Southwest Research Institute indicate that for 4-stroke motorcycles, evaporative and crankcase hydrocarbons are approximately thirty percent of exhaust hydrocarbons. For 2-stroke motorcycles, evaporative hydrocarbons are approximately two percent of exhaust hydrocarbons.

standards will be in effect:

1. Light Duty Vehicles - The 1975 interim standards are in effect until 1977. In 1977, the 1975 interim HC and CO standards of HC = 1.5 grams/mile and CO = 15. grams/mile will remain in effect. The NO_x standard will be 2.0 grams/mile. Beginning in 1978, light duty vehicles are assumed to meet statutory HC and CO levels. A gradually decreasing schedule of NO_x control has been assumed (as discussed in AP- 42, supplement 5). It is assumed that evaporative emissions will be reduced to .7 grams/mile starting in 1979.

2. Light Duty Trucks - In the analysis, light duty trucks are defined as all trucks with gross vehicle weights below 8500 pounds. Until 1978, trucks below 6000 pounds are assumed to be regulated at levels of HC = 2.0 grams/mile, CO = 73 grams/mile, and NO_x = 6.9 grams/mile. In 1978, all light duty trucks are assumed to be regulated to standards of HC = 1.7 grams/mile, CO = 18 grams/mile and NO_x = 2.3 grams/mile. These standards are in the process of being proposed. No further reductions for LDTs have been assumed, although evaporative emissions are assumed to be reduced to .7 grams/mile beginning with the 1979 model year.

3. Heavy Duty Vehicles - In this analysis, heavy duty vehicles are defined as all trucks with gross vehicle weights above 8500 pounds GVW. Until 1978, these trucks are assumed to be regulated at levels of HC + NO_x = 16 grams/brake horsepower-hour and CO = 40 grams/brake horsepower hour. These levels represent approximately 53%, 32%, and 4% HC, CO, and NO_x control from uncontrolled levels for gasoline trucks and 26%, 0%, and 0% control from uncontrolled levels for Diesel trucks.

In 1978, heavy duty trucks are assumed to be regulated at levels equivalent to 75%, 41%, and 20% control from uncontrolled levels for gasoline trucks and 26%, 0%, and 9% control from uncontrolled levels for Diesel trucks. No further control of heavy duty trucks has been assumed for post-1978.

4. Motorcycles - No control of motorcycles has been assumed.

To give a range on the potential impact of uncontrolled motorcycles in 1990, two other cases have been hypothesized regarding standards. Case I assumes that light duty vehicles remain at interim 1977 levels until 1990, all other standards remain as stated above. This case simulates the lowest expected control level for mobile sources in 1990. Case II assumes that light duty trucks, and heavy duty gasoline trucks have HC, CO, and NO_x reductions equivalent to the light duty statutory reductions and heavy Diesel trucks have NO_x reductions equivalent to light duty vehicle statutory reductions. These reductions are assumed to be implemented in early 1980 so that by 1990, the entire mobile source population would be controlled to very stringent levels. Table 8 gives the percent motorcycle contribution in 1990 for each of the geographic regions assuming low and high mobile source control options.

Appendix 2 presents a graphical illustration of the motorcycle emission inventory for the national case and for Los Angeles as a function of calendar year. Included on the graph are the projected emission inventories if the proposed interim standards and the proposed final standards are adopted for motorcycles. These projections use the input data discussed in Appendix 1.

Motorcycle emissions can also be examined as a percentage of the allowable ambient air quality standard. That is, the NAAQS will be attained when total emissions from all sources, mobile and stationary, are at a given level. This level (in tons/day or tons/year) will vary from region to region due to differences in meterological conditions, terrain, etc. Tables 1-8 indicate that motorcycle emissions can be expected to be substantial contributors to total mobile source emissions in 1990. However, projections by Office of Air Quality Planning and Standards indicate that mobile sources will only be between twenty and forty percent of the total hydrocarbon problem by 1990 in the regions examined in this analysis. Calculations to determine motorcycle emissions as a percentage of emissions allowable if standards are to be attained indicate that in 1990 in the AQCRs examined, uncontrolled motorcycles will be between three and twelve percent of the total allowable emissions (mobile and stationary) if the oxident standard is to be achieved. The details of these calculations are given in Appendix 3.

Conclusions

Many regions are expected to continue having problems meeting oxidant and carbon monoxide ambient air quality standards in the 1980-1990 time frame. The six regions examined in this study are a subset of the approximately 25 regions which have been identified as potential problem regions. Results of emission assessments in these regions lead to the following conclusions:

1. Motorcycle HC and CO emissions are of equal importance in a wide range of AQCRs.

2. The biggest potential impact of motorcycle emissions is in high altitude areas such as Denver and Salt Lake City. With the advent of high altitude emission regulations in 1977 for light duty vehicles, the emission inventories in high altitude geographic regions should show a marked decrease. High altitude regulations have not been postulated for motorcycles. Therefore, to the extent that altitude affects the air fuel ratios for motorcycles and to the extent that this situation is not compensated for with maintenance adjustments, motorcycle emissions can be expected to be signficiantly higher in high altitude locations. Thus motorcycles compose a larger fraction of total mobile source emissions at high altitudes than is expected at low altitudes.

3. Until such time as light duty vehicles are controlled more stringently than the 1975 interim levels, motorcycles remain relatively minor contributors to total mobile source emission inventories in all AQCRs. This is not because the emissions in grams per motorcycle mile are low but becuase the total number of motorcycle miles are low.

4. Motorcycles are not as significant CO contributors as they are HC contributors. This is directly attributable to the fact that at the present time, gasoline HDVs are expected to remain significant CO contributors for at least the next six years. Although the proposed interim HDV standards will reduce the HDV HC contribution, the CO contribution cannot be significantly reduced until a revised gasoline HDV test procedure is developed. Such an action is at least six years away.

5. Once LDV, LDT, and HDV emissions are reduced to levels approximating 95% HC and CO control, motorcycles become major mobile source contributors if they are not controlled. The currently proposed motorcycle standards (interim standards in 1978 with LDV statutory equivalent standards in 1980) would result in a 90% HC and CO emission reduction from motorcycles by 1990. A continuation

of the 1978 interim standards out to 1990 would reduce motorcycle HC emission by 40% and CO emission by 15% by calendar year 1990. (The possibility of significantly greater control exists if manufacturers redirect their marketing lines as a result of interim standards.) However, these interim standards have only been proposed as two year standards. Any decision to extend these standards should be preceded by a thorough assessment of available technology and cost effectiveness. Such an assessment will be performed in response to the NPRM comments.

6. By 1990, the uncontrolled motorcycle contribution to the total mobile source contribution is projected to range from 3.1 to 20.6 percent for hydrocarbons and 1.3 to 16.1 percent for carbon monoxide. Specific values for each of the six AQCRs as well as the national case are summarized in the following table.

1990 Uncontrolled Motorcycle Contribution as % of
Total Mobile Source Contribution

	Least Stringent LDV-1975 interim CDT-1978 interim HDV-1978 interim		Presently Planned LDV-1978 statutory LDT-1978 interim HDV-1978 interim		Most Stringent LDV-1978 statutory LDT-90% reduction HDV-90% reduction	
	HC	CO	HC	CO	HC	CO
National	3.2	1.7	7.0	3.3	9.4	7.6
Phoenix	3.2	1.8	7.4	3.7	10.0	8.7
Salt Lake City	6.9	4.0	16.0	7.7	20.6	16.1
Denver	5.2	2.5	11.3	4.1	15.4	13.1
Houston	3.8	2.1	9.0	4.3	11.8	9.8
New Jersey	2.4	1.3	5.7	2.7	7.8	6.2
Los Angeles	3.1	2.0	7.8	4.5	9.6	8.7

Table 1

Nationwide Mobile Source Emission Projections

TOTAL EMISSIONS (in ton/yr.)
FOR
THE NATION

Year	Light Duty Vehicles	Light Duty Trucks	Heavy Duty Diesels	Heavy Duty Gasoline	Motorcycles	Mobile Source Total	Motorcycle Percent of Total
	HC	$\times 10^6$					
1972	9.98	2.36	.201	2.37	.0790	14.99	.53%
1974	9.72	2.18	.221	2.23	.115	14.47	.79%
1976	8.39	1.92	.229	2.04	.137	12.72	1.1 %
1978	7.25	1.76	.238	1.87	.159	11.28	1.4 %
1980	5.88	1.45	.248	1.57	.179	9.33	1.9 %
1985	2.79	.858	.274	1.09	.218	5.23	4.2 %
1990	1.73	.635	.303	.857	.265	3.79	7.0 %
	CO	$\times 10^7$					
1972	7.64	1.36	.126	1.40	.0295	10.56	.28%
1974	7.34	1.28	.138	1.46	.0391	10.26	.38%
1976	5.91	1.12	.143	1.43	.0417	8.64	.48%
1978	4.54	.959	.149	1.40	.0486	7.10	.68%
1980	3.20	.736	.155	1.32	.0546	5.47	1.0 %
1985	1.14	.454	.171	1.18	.0664	3.01	2.2 %
1990	.650	.343	.189	1.15	.0808	2.41	3.3 %
	NOx	$\times 10^6$					
1972	4.45	.769	.914	.532	.0017	6.67	.03%
1974	4.70	.844	1.00	.672	.0019	7.22	.03%
1976	4.77	.881	1.04	.760	.0019	7.45	.03%
1978	4.23	.894	1.07	.834	.0022	7.03	.03%
1980	3.29	.842	1.09	.886	.0024	6.11	.04%
1985	1.53	.707	1.20	.105	.0030	3.55	.08%
1990	1.10	.618	1.32	.117	.0036	3.16	.11%

Table 2

Phoenix-Tuscon AQCR Mobile Source
Emission Projections

TOTAL EMISSIONS (in ton/yr)

For
PHOENIX-TUSCON AQCR

Year	Light Duty Vehicles	Light Duty Trucks	Heavy Duty Diesels	Heavy Duty Gasoline	Motorcycles	Mobile Source Total	Motorcycle Percent of Total
	HC		x 10^4				
1972	8.99	1.92	.0406	1.83	.102	12.9	.79%
1974	8.78	1.84	.0456	1.75	.149	12.6	1.2%
1976	8.18	1.74	.0507	1.74	.178	11.9	1.5%
1978	7.56	1.69	.0558	1.68	.198	11.2	1.8%
1980	6.53	1.42	.0608	1.45	.214	9.67	2.2%
1985	3.41	.907	.0710	1.09	.261	5.74	4.5%
1990	2.08	.707	.0862	.926	.305	4.10	7.4%
	CO		x 10^5				
1972	6.80	1.11	.0253	1.14	.0377	9.11	.41%
1974	6.59	1.08	.0285	1.18	.0503	8.93	.56%
1976	5.84	.990	.0316	1.23	.0535	8.15	.65%
1978	4.85	.905	.0348	1.27	.0601	7.12	.84%
1980	3.65	.714	.0380	1.25	.0650	5.72	1.1%
1985	1.51	.492	.0443	1.20	.0790	3.33	2.4%
1990	.758	.379	.0538	1.24	.0925	2.52	3.7%
	NOx		x 10^4				
1972	3.79	.665	.184	.465	.0019	5.11	.04%
1974	4.12	.718	.207	.582	.0024	5.63	.04%
1976	4.44	.796	.230	.677	.0024	6.15	.04%
1978	4.29	.841	.250	.776	.0027	6.16	.04%
1980	3.57	.814	.267	.865	.0029	5.52	.05%
1985	1.92	.765	.312	1.08	.0035	4.08	.09%
1990	1.34	.692	.378	1.25	.0041	3.66	.11%

Table 3

Salt Lake County, Utah Mobile Source
Emission Projections

TOTAL EMISSIONS (in ton/yr)

For
WASATCH AQCR

Year	Light Duty Vehicles	Light Duty Trucks	Heavy Duty Diesels	Heavy Duty Gasoline	Motorcycles	Mobile Source Total	Motorcycles Percent of Total
	HC	$\times 10^4$					
1972	2.52	.529	.0091	.267	.0669	3.39	2.0%
1974	2.49	.513	.0100	.242	.0907	3.35	2.7%
1976	2.35	.496	.0111	.236	.104	3.20	3.3%
1978	2.18	.474	.0122	.224	.108	3.00	3.6%
1980	1.88	.383	.0134	.199	.112	2.59	4.3%
1985	.866	.229	.0148	.150	.124	1.38	9.0%
1990	.423	.143	.0163	.138	.137	.857	16.0%
	CO	$\times 10^5$					
1972	2.33	.373	.0057	.197	.0284	2.93	.96%
1974	2.43	.391	.0062	.207	.0319	3.07	1.0%
1976	2.25	.379	.0069	.218	.0327	2.89	1.1%
1978	1.90	.329	.0076	.231	.0340	2.50	1.4%
1980	1.48	.257	.0084	.247	.0353	2.03	1.7%
1985	.526	.160	.0092	.259	.0390	.993	3.9%
1990	.150	.0717	.0102	.284	.0431	.559	7.7%
	NOx	$\times 10^3$					
1972	5.26	.879	.412	.356	.0053	6.91	.077%
1974	6.31	1.11	.454	.460	.0062	8.34	.074%
1976	7.63	1.36	.502	.570	.0059	10.1	.058%
1978	7.75	1.51	.543	.697	.0061	10.5	.058%
1980	6.99	1.53	.584	.854	.0064	9.96	.064%
1985	4.06	1.55	.644	1.10	.0071	7.36	.096%
1990	2.69	1.30	.712	1.30	.0078	6.01	.13%

Table 4

Denver AQCR Mobile Source
Emission Projections

TOTAL EMISSIONS (in ton/yr)
for
DENVER AQCR

Year	Light Duty Vehicles	Light Duty Trucks	Heavy Duty Diesels	Heavy Duty Gasoline	Motorcycles	Mobile Source Total	Motorcycles Percent of Total
	HC	$x\ 10^4$					
1972	7.81	1.50	.0552	1.63	.112	11.1	1.0%
1974	7.87	1.49	.0618	1.58	.171	11.2	1.5%
1976	7.05	1.39	.0654	1.50	.196	10.2	1.9%
1978	6.20	1.29	.0695	1.38	.212	9.15	2.3%
1980	5.09	1.01	.0735	1.17	.229	7.57	3.0%
1985	2.15	.607	.0816	.859	.274	3.97	6.9%
1990	1.16	.375	.0898	.755	.302	2.68	11.3%
	CO	$x\ 10^5$					
1972	7.36	1.04	.0345	1.20	.0434	9.68	.45%
1974	7.80	1.12	.0386	1.29	.0602	10.31	.58%
1976	6.73	1.06	.0408	1.30	.0618	9.19	.67%
1978	5.28	.906	.0433	1.34	.0669	7.63	.88%
1980	3.85	.671	.0459	1.37	.0723	6.01	1.2%
1985	1.16	.431	.0509	1.44	.0863	3.17	2.7%
1990	.429	.184	.0560	1.56	.0953	2.32	4.1%
	NOx	$x\ 10^4$					
1972	1.74	.224	.251	.215	.00089	2.45	.04%
1974	2.12	.313	.281	.272	.00116	2.99	.04%
1976	2.45	.369	.297	.325	.00112	3.44	.03%
1978	2.35	.405	.311	.383	.00121	3.45	.04%
1980	1.97	.391	.321	.455	.00131	3.14	.04%
1985	1.01	.399	.356	.594	.00156	2.36	.07%
1990	.726	.330	.392	.714	.00172	2.16	.08%

Table 5

Houston-Galveston AQCR Mobile Source

Emission Projections

TOTAL EMISSIONS (in ton/yr)

for
HOUSTON-GALVESTON AQCR

Year	Light Duty Vehicles	Light Duty Trucks	Heavy Duty Diesels	Heavy Duty Gasoline	Motorcycles	Mobile Source Total	Motorcycles Percent Of Total
	HC		$\times 10^5$				
1972	1.19	.204	.0108	.230	.0117	1.65	.71%
1974	1.18	.190	.0120	.209	.0157	1.61	.97%
1976	1.08	.177	.0132	.203	.0189	1.49	1.3%
1978	.982	.168	.0145	.188	.0220	1.37	1.6%
1980	.841	.144	.0160	.163	.0257	1.19	2.2%
1985	.400	.0833	.0176	.123	.0363	.660	5.5%
1990	.249	.0654	.0195	.114	.0442	.492	9.0%
	CO		$\times 10^5$				
1972	9.11	1.21	.0674	1.51	.0434	11.9	.36%
1974	8.88	1.15	.0747	1.55	.0531	11.7	.45%
1976	7.59	1.02	.0822	1.61	.0572	10.4	.55%
1978	6.15	.893	.0902	1.61	.0668	8.81	.75%
1980	4.58	.710	.0996	1.58	.0779	7.05	1.1%
1985	1.63	.442	.110	1.46	.110	3.75	2.9%
1990	.931	.375	.121	1.53	.134	3.09	4.3%
	NOx		$\times 10^4$				
1972	5.31	.763	.491	.669	0.0022	7.24	.03%
1974	5.70	.827	.544	.851	0.0025	7.92	.03%
1976	6.13	.916	.599	1.00	0.0026	8.65	.03%
1978	5.73	.945	.644	1.13	0.0030	8.45	.04%
1980	4.71	.908	.696	1.24	0.0035	7.56	.05%
1985	2.20	.754	.768	1.38	0.0049	5.11	.12%
1990	1.58	.704	.848	1.53	0.0060	4.67	.13%

Table 6

New Jersey Mobile Source
Emission Projection

TOTAL EMISSIONS (in ton/yr)

for
N.J. Portion of N.Y.,N.J., Conn AQCR

Year	Light Duty Vehicles	Light Duty Trucks	Heavy Duty Diesels	Heavy Duty Gasoline	Motorcycles	Mobile Source Total	Motorcycle Percent of Total
HC $\times 10^5$							
1972	2.76	.484	.0249	.573	.00950	3.85	.24%
1974	2.56	.435	.0260	.492	.0138	3.53	.39%
1976	2.22	.383	.0270	.454	.0178	3.10	.57%
1978	1.91	.345	.0281	.401	.0208	2.70	.76%
1980	1.54	.277	.0293	.333	.0243	2.20	1.1%
1985	.732	.165	.0323	.244	.0357	1.21	2.9%
1990	.456	.125	.0356	.210	.0505	.877	5.7%
CO $\times 10^6$							
1972	2.11	.285	.0156	.357	.00355	2.77	.12%
1974	1.93	.259	.0162	.347	.00468	2.56	.18%
1976	1.56	.220	.0169	.340	.00544	2.14	.25%
1978	1.20	.184	.0175	.325	.00634	1.73	.36%
1980	.840	.138	.0183	.304	.00740	1.31	.56%
1985	.299	.0878	.0202	.277	.0109	.695	1.6%
1990	.170	.0699	.0222	.281	.0154	.559	2.7%
NOx $\times 10^5$							
1972	1.23	.176	.113	.143	.00019	1.67	.011%
1974	1.24	.179	.118	.177	.00022	1.71	.013%
1976	1.26	.188	.123	.197	.00024	1.77	.014%
1978	1.11	.185	.126	.214	.00028	1.64	.017%
1980	.864	.168	.129	.225	.00033	1.39	.024%
1985	.402	.144	.142	.256	.00049	.944	.052%
1990	.289	.130	.157	.283	.00069	.860	.080%

Table 7

Los Angeles AQCR Mobile Source
Emission Projection

TOTAL EMISSIONS (in ton/yr)
for
LA AQCR

Year	Light Duty Vehicles	Light Duty Trucks	Heavy Duty Diesels	Heavy Duty Gasoline	Motorcycles	Mobile Source Total	Motorcycle Percent of Total
	HC		$x\ 10^6$				
1972	.433	.0660	.00568	.0586	.00736	.571	1.3%
1974	.406	.0606	.00598	.0522	.00847	.533	1.6%
1976	.367	.0572	.00634	.0451	.00971	.485	2.0%
1978	.309	.0505	.00669	.0378	.0101	.414	2.4%
1980	.244	.0436	.00709	.0316	.0105	.337	3.1%
1985	.122	.0281	.00801	.0242	.0116	.194	6.0%
1990	.0968	.0208	.00908	.0246	.0128	.164	7.8%
	CO		$x\ 10^7$				
1972	.369	.0409	.00354	.0376	.00274	.454	.60%
1974	.325	.0377	.00373	.0373	.00286	.407	.70%
1976	.266	.0348	.00395	.0365	.00294	.344	.85%
1978	.201	.0289	.00418	.0350	.00306	.272	1.1%
1980	.143	.0245	.00443	.0331	.00319	.208	1.5%
1985	.0488	.0158	.00500	.0310	.00352	.104	3.4%
1990	.0320	.0114	.00566	.0330	.00389	.0859	4.5%
	NOx		$x\ 10^6$				
1972	.200	.0235	.0258	.0148	.000140	.264	.05%
1974	.203	.0245	.0272	.0183	.000137	.273	.05%
1976	.196	.0252	.0280	.0209	.000132	.270	.05%
1978	.172	.0259	.0293	.0230	.000137	.250	.05%
1980	.135	.0246	.0311	.0253	.000143	.216	.07%
1985	.0670	.0227	.0351	.0294	.000157	.154	.10%
1990	.0541	.0204	.0397	.0333	.000174	.148	.12%

Table 8

1990 Motorcycle Emission Contribution to total Mobile Source Contribution by Control Strategy (Motorcycle Contribution expressed as % of Total)

	Strategy 1/					
	1		2		3	
	HC	CO	HC	CO	HC	CO
National	3.2	1.7	7.0	3.3	9.4	7.6
Phoenix	3.2	1.8	7.4	3.7	10.0	8.7
Salt Lake City	6.9	4.0	16.0	7.7	20.6	16.1
Denver	5.2	2.5	11.3	4.1	15.4	13.1
Houston	3.8	2.1	9.0	4.3	11.8	9.8
New Jersey	2.4	1.3	5.7	2.7	7.8	6.2
Los Angeles	3.1	2.0	7.8	4.5	9.6	8.7

1/Strategy 1 is the least stringent mobile source control strategy. It assumes light duty vehicles remain at 1975 levels; light duty trucks are controlled to light duty vehicle interim equivalent levels; heavy duty vehicles are controlled to levels slightly less stringent than those proposed for 1978. No further control is assumed

Strategy 2 assumes that levels currently proposed will in fact be implemented. Light duty vehicles will go to statutory levels in 1978. Light duty trucks and heavy duty trucks will be regulated as in strategy 1.

Strategy 3 is the most stringent mobile source control option. Light duty vehicles will be controlled to statutory in 1978. Light duty trucks will achieve the same reductions in emissions (from a pre-control baseline) as LDVs starting in 1980 and heavy duty gasoline vehicles will achieve the same reductions in emissions as LDVs starting in 1981. LDTs and HDVs will have interim control as described in strategies 1 and 2.

Appendix I: Usage Data

DATA SUMMARY FOR THE NATION

I. Emission Rates:

A. Motorcycles - EPA Data, SwRI Data, and Motorcycle Manufacturers' Data were used to obtain a linear regression of emission rate vs. displacement. (Separate regressions for 2-stroke and 4-stroke engines).Using these regressions an emission rate for 4 engine classes was obtained by weighting the emission rates according to the fraction of motorcycles in each subclass. Gallup Data were used for this purpose; they were divided into 8 displacement classes and into 2-stroke and 4-stroke.

Interim emission rates were based on the proposed interim standards. It was assumed that where moderate control was required to meet HC and CO standards, the NOx emission rate would rise 3 times (300%), and where significant control was required to meet HC and CO standards the NOx rate would increase 5 times (500%). This was based on engineering calculations.

Final emission rates are assumed to be at the LDV statutory levels.

Emission Rates gm/km

	Uncontrolled			Interim			Statutory		
Engine Class	HC	CO	NOx	HC	CO	NOx	HC	CO	NOx
2S < 170cc	8.3	14.5	.025	5.0	14.5	.075	.25	2.1	.25
2S > 170cc	12.0	18.1	.025	7.29	16.8	.125	.25	2.1	.25
4S < 170cc	.9	11.7	.15	.9	11.7	.15	.25	2.1	.25
4S > 170cc	1.7	23.4	.15	1.7	16.7	.45	.25	2.1	.25

B. Other Vehicles - The low altitude emission rates in AP-42 were used

II. Vehicle Mix By Age

A. Motorcycles - The Gallup Data were used to obtain the number of motorcycles of each model year for the four engine classes. (Note, this breakdown did not appear in the published report, but was obtained from the Gallup Data on file). This distribution was assumed to remain constant for all calendar years.

Fraction of Motorcycle Population as Function of Age (National Average)

Engine / Age	0	1	2	3	4	5	6	7	8	9	10	11	12 +
2S < 170cc	.058	.237	.212	.123	.114	.074	.048	.037	.035	.035	.012	-	.014
2S > 170cc	.123	.218	.244	.155	.081	.062	.047	.025	.023	.007	.006	.003	.006
4S < 170cc	.083	.164	.131	.157	.138	.069	.057	.061	.050	.046	.015	.011	.018
4S > 170cc	.126	.243	.192	.157	.086	.052	.039	.029	.024	.021	.005	.009	.016

B. Other Vehicles. The national average values in AP-42 were used.

III. Mileage Accumulation Rate

A. Motorcycles - Data on mileage accumulation were obtained from the EPA Standards Development and Support Branch report on "Motorcycle Useful Life". From that data approximate rates of mileage accumulation were obtained as a function of age. Only two engine classes were used (See Figure 1).

Mileage Accumulation Rate By Age (Miles/year) (National Average)

Engine / Age(yr)	0	1	2	3	4	5	6	7	8	9	10	11	12+
< 170 cc	2160	1685	1168	1084	1000	917	833	750	666	583	499	415	415
> 170 cc	4342	3384	2390	2317	2245	2173	2101	2030	1958	1885	1813	1741	1741

B. Other Vehicles - The national average values in AP-42 were used.

IV. Vehicle Miles Traveled

A. Motorcycles - Since no accurate VMT estimates are available for the entire motorcycle population, VMT's were calculated as follows: A weighted average VMT value per motorcycle was obtained using the above data on mileage accumulation and the vehicle mix data. These values are shown below.

Average Miles Per Year (National Average)

Engine	2S < 170cc	2S > 170 cc	4S < 170 cc	4S > 170cc
Miles	1211.	2765.	1153.	2778.

Total VMT's were obtained by multiplying the number of motorcycles in each class times the average VMT value. The number of motorcycles in each class was calculated using total motorcycle registrations (from Dept. of Transportation Data) and assuming a breakdown as indicated by Gallup Data and by R. L. Polk Co. Data, as shown below.

Fraction of Motorcycles in Each Engine Class (National Average)

Engine / Year	2S<170cc	2S>170cc	4S<170cc	4S>170	Source
1971	.17	.24	.18	.41	Estimate
1972	.17	.24	.18	.41	R.L.Polk Data (1972)
1973	.19	.255	.155	.40	Estimate
1974	.21	.27	.13	.39	Gallup Data (1974) (All Model Yrs)
1975	.22	.29	.12	.37	Estimate
1976+	.23	.31	.11	.35	Gallup Data (1974) (72-74 Model Yrs Only)

Future VMT's were calculated assuming the following growth rates:

8% Until 1980

4% Thereafter

(Note: Between 1969 and 1974 Motorcycle Registrations have increased at least 14% each year, nationwide. A slowing of this growth rate is occurring in 1975 and is expected to continue.)

B. Other Vehicles - Department of Transportation statistics were used to obtain total VMT's. The national average fraction of VMT's by each vehicle type as in AP-42 was used to determine VMT's for each type of vehicle (LDV's - 80.4%, LDT's - 11.8%, HD Diesels - 3.2%, HD Gas - 4.6%) Future VMTs were calculated assuming a growth rate of 2% per year.

DATA SUMMARY FOR PHOENIX - TUSCON AQCR

I. Emission Rates

A. Motorcycles - The Emission Rates as shown on A-1 were used.

B. Other Vehicles - AP-42 low altitude emission rates were used.

II. Vehicle Mix By Age

A. Motorcycles - It was assumed that because of climate similarities the Gallup Data for Los Angeles would more closely approximate the vehicle mix than would national average data. Unfortunately the California data were not broken down into engine classes. The California data for all motorcycles were compared with the national data for all motorcycles (see Fig. 3) Using Fig. 3 as a guide the national distributions for each engine class were altered to reflect the same differences as the distributions for all motorcycles.

Fraction of Motorcycles by Age (Warm Climate)

Engine/ Age	0	1	2	3	4	5	6	7	8	9	10	11	12+
2S < 170cc	.042	.150	.170	.130	.150	.120	.080	.050	.040	.030	.020	.010	.010
2S > 170cc	.090	.140	.200	.170	.110	.100	.080	.030	.030	.020	.010	.010	.020
4S < 170cc	.060	.100	.100	.170	.190	.110	.090	.070	.040	.040	.010	.010	.010
4S > 170cc	.090	.150	.150	.170	.120	.080	.080	.050	.030	.030	.020	.010	.020

B. Other Vehicles - The fraction of vehicles by age for the other types of vehicles came from a variety of sources.

1) LDVs - The following data are from "A Transportation Control Strategy for the Phoenix Tuscon Air Quality Area", APTD 1369 Feb. 1973.

LDV Age	0	1	2	3	4	5	6	7	8	9	10	11	12+
Fraction	.059	.098	.107	.094	.088	.094	.092	.079	.071	.056	.037	.035	.090

2) LDTs - These data are from R. L. Polk Data for 1973; it was supplied by EPA, North Carolina. The data were for all heavy duty vehicles; they were broken down by weight class, but the breakdowns do not follow the LDT-HDT cutoff of 8,500 lb. The following is therefore data for all trucks less than 10,000 lb. (1973 data)

LDV Age	0	1	2	3	4	5	6	7	8	9	10	11	12+
Fraction	.088	.136	.080	.081	.079	.059	.054	.055	.049	.046	.039	.031	.202

3) HDDs & HDGs - These data are from the same source as the LDT data, this being for trucks greater than 10,000 lb. It is probably not completely

accurate to assume the same distribution for gas and diesel trucks, but since the diesel HC & CO emission rates do not change and the NOx rate changes only slightly the distribution of diesels is not an important factor. The following distribution should fairly represent the gasoline heavy duty distribution.

(1973 Polk Data)

HDV Age	0	1	2	3	4	5	6	7	8	9	10	11	12+
Fraction	.071	.102	.075	.078	.079	.052	.057	.057	.053	.055	.046	.036	.237

III. Mileage Accumulation Rate By Age

A. Motorcycles - Gallup Data indicated motorcycles in California (warm climate) accumulated more mileage than the national average. The Gallup Data were not broken down into engine classes, so accumulated mileage of all types of motorcycles in Los Angeles was compared with nationwide data for all types of motorcycles (Fig. 2). In the early years the warm climate motorcycles accumulated 1.3 times more mileage on the average. This factor was assumed to be constant for all motorcycles in all classes and all years. Therefore the table below was obtained by multiplying national average values times 1.3.

Mileage Accumulation Rate By Age (Warm Climate)

Engine/Age	0	1	2	3	4	5	6	7	8	9	10	11	12+
< 170 cc	2808	2190	1518	1409	1300	1192	1082	975	865	757	649	540	540
> 170 cc	5644	4399	3107	3012	2919	2825	2731	2639	2545	2451	2357	2263	2263

B. Other Vehicles - National average values in AP-42 were used.

IV. Vehicles Miles Traveled

A. Motorcycles - Using the warm climate accumulated mileage data, the following weighted averages of yearly VMT were calculated

Average Miles Per Year (Warm Climate)

Engine	2S < 170cc	2S > 170cc	4S < 170cc	4S > 170cc
Miles	1442.	3375.	1405.	3338.

These average yearly mileage figures were multiplied by the number of motorcycles in each class to obtain total VMT values for each engine class. The total number of motorcycles registered in Arizona is available from Department of Transportation statistics. A breakdown of registrations by counties was available for 1972 (from Arizona Highway Department). In 1972 81% of Arizona's motorcycles were registered in the Phoenix-Tuscon AQCR. This was assumed to remain constant.

The breakdown between engine classes was assumed to be the same as the national average.

Future VMTs were calculated assuming the following growth rates:

8% until 1978. At that time there will be approximately 4 motorcycles per 100 people in the population.

4% until 1989. 5 motorcycles per 100 people.

2% thereafter.

Since 1969 motorcycle registrations have increased between 14-26% per year.

B. Other Vehicles - EPA North Carolina provided data from the Arizona Highway Department on total VMTs for each county in Arizona in 1972. Based on data in "A Transportation Control Strategy for the Phoenix-Tuscon AQ Area", APTD 1369, Feb. 1973. The fraction of VMTs by each type vehicle was assumed to be:

Vehicle	LDVs	LDTs	HDDs	HDG
% of VMTs	82.7%	12%	.8%	4.5%

From the same source came the basis of growth estimates for future VMTs:

5% Until 1980

3% Thereafter

DATA SUMMARY FOR SALT LAKE COUNTY, UT

I. Emission Rates

A. Motorcycles - Salt Lake City is at relatively high altitude, and while altitude effects on motorcycle emissions are unknown it was assumed the uncontrolled motorcycle emission rates at high and low altitude would be in the same ratio as LDV emission rates at high and low altitude. These ratios for uncontrolled LDVs are:

High Alt/Low Alt : HC = 1.45, CO = 1.5, NOx = .62

Applying these to motorcycles gives the following

High Altitude Motorcycle Emissions (Uncontrolled)

gm/km	2S < 170cc	2S > 170cc	4S < 170cc	4S > 170cc
HC	12.0	17.4	1.3	2.5
CO	21.8	27.2	17.6	35.1
NOx	.015	.015	.09	.09

B. Other Vehicles - The high altitude emission rates in AP-42 were used.

II. Vehicle Mix By Age

A. Motorcycles - National average values were used.

B. Other Vehicles-

1) LDVs - Data from "Transportation Controls to Reduce Motor Vehicle Emissions in Salt Lake City, Utah," APTD 1445, Dec. 1972; was used.

LDV Age	0	1	2	3	4	5	6	7	8	9	10	11	12+
Fraction	.073	.085	.096	.092	.086	.091	.093	.081	.073	.062	.042	.035	.090

2) LDTs - Polk Data supplied by EPA, N.C. were used. The following is actually the distribution of trucks less than 10,000 lb. in Salt Lake County. (1973 data)

LDT Age	0	1	2	3	4	5	6	7	8	9	10	11	12+
Fraction	.100	.126	.086	.076	.082	.065	.055	.055	.051	.048	.040	.034	.183

3) HDDs & HDGs - Polk Data for all trucks greater than 10,000 lb. for Salt Lake County (1973 Data)

HDV Age	0	1	2	3	4	5	6	7	8	9	10	11	12+
Fraction	.099	.120	.086	.083	.085	.061	.059	.054	.049	.048	.040	.034	.183

III. Mileage Accumulation Rate By Age

A. Motorcycles - National average mileage was used.

B. Other Vehicles - National average mileage was used.

IV. Vehicle Miles Traveled

A. Motorcycles - VMTs were calculated using national average miles per year values. Total motorcycles registered in Salt Lake County were known for 1973 (Utah Highway Dept. Statistics). This was 48% of Utah's registered motorcycles. This ratio was assumed to remain constant. National average engine class breakdown was assumed. Future growth was assumed to be only 2% per year because of the large motorcycle population.

B. Other Vehicles - EPA, N.C. provided data on total VMTs in each Utah County in 1972. These data were from an EPA contractor's measurements.

The VMT breakdown between vehicle types was assumed to be LDV-85%, LDT - 11.75%, HDD -.81%, HDG - 2.4%.

This is based on data contained in "Transportation Control to Reduce Motor Vehicle Emission in Salt Lake City, Utah" APTD 1443, Dec. 1972. Future VMTs were calculated assuming growth of:

5% per year until 1980 and

2% thereafter

The 5% figure is based on data in the same reference.

DATA SUMMARY FOR DENVER AQCR

I. Emission Rates

A. Motorcycles - High altitude emission rates were used.

B. Other Vehicles - High altitude emission rates as in AP-42 were used.

II. Vehicle Mix By Age

A. Motorcycles - National average values were used.

B. Other Vehicles

1) LDVs - National averages were used from AP-42.

2) LDTs - Polk Data for trucks less than 10,000 lb for the four most populous counties in the Denver AQCR were used: (1973 Data)

LDT Age	0	1	2	3	4	5	6	7	8	9	10	11	12+
Fraction	.062	.139	.093	.083	.083	.060	.055	.053	.047	.045	.037	.034	.209

3) HDDs & HDGs - Polk Data for vehicles greater than 10,000 lb for the four most populous counties in the Denver AQCR were used.

HDV Age	0	1	2	3	4	5	6	7	8	9	10	11	12+
Fraction	.081	.127	.080	.052	.067	.060	.049	.057	.052	.052	.043	.039	.240

III. Mileage Accumulation Rate By Age

A. Motorcycles - National averages were used.

B. Other Vehicles - National averages were used from AP-42.

IV. Vehicle Miles Traveled

A. Motorcycles - VMTs were calculated using the following data: National average miles per year values ; total motorcycle registrations in Denver AQCR (From Colorado Highway Dept. for 1972, and assuming the same ratio of 54% of Colorado's motorcycles in Denver AQCR for other years)

Growth Rates of:

4% until 1985 (5 motorcycles per 100 people)

2% thereafter

(Motorcycle Registrations in Colorado have increased between 29% and 16% per year since 1968)

National average breakdown of engine classes

B. Other Vehicles - EPA, N.C. provided data on total VMTs by county. The base value used was estimated VMTs for the year 1973 from the EPA contractor.

The national average urban VMT breakdown was used.

LDV - 84%, LDT 10%, HDD - 1.5%, HDG 4.5% (From M. Williams)

Estimated growth rates were

3% until 1980

2% thereafter

(Guesses)

DATA SUMMARY FOR HOUSTON - GALVESTON AQCR

I. Emission Rates

A. Motorcycles - Low altitude emission rates were used.

B. Other Vehicles - Low altitude emission rates in AP-42 were used.

II. Vehicle Mix By Age

A. Motorcycles - The warm climate vehicle mix was used

B. Other Vehicles

1) LDVs - National average values in AP-42 were used.

2) LDTs - Polk Data for all trucks under 10,000 lb in the four most populous counties in the Houston-Galveston AQCR were used: (1973 Data)

LDT Age	0	1	2	3	4	5	6	7	8	9	10	11	12+
Fraction	.121	.136	.103	.095	.098	.081	.069	.064	.055	.041	.029	.023	.085

3) HDDs & HDGs - Polk Data for all vehicles greater than 10,000 lb. in the four most populous counties in the Houston-Galveston AQCR were used: (1973 Data)

HDV Age	0	1	2	3	4	5	6	7	8	9	10	11	12+
Fraction	.114	.131	.108	.107	.111	.080	.069	.064	.052	.038	.027	.021	.078

III. Mileage Accumulation Rate By Age

A. Motorcycles - Warm climate values were used.

B. Other Vehicles - National average values in AP-42 were used.

IV. Vehicle Miles Traveled

A. Motorcycles - VMTs were calculated using the following data:
Warm climate average miles travelled per year;
Total motorcycle registrations in Houston-Galveston AQCR (The ratio of registrations in Houston-Galveston AQCR to registrations in Texas was assumed to stay the same for all years: in 1972 21% of Texas motorcycles were in the Houston-Galveston AQCR);
National average breakdown of engine classes;
Future Growth Rates of

8% until 1985 (4 motorcycles per 100 people)

4% until 1992 (5 motorcycles per 100 people)

2% thereafter (Growth has been 11-31% per yr since 1968)

B. Other Vehicles - EPA, N.C. provided data from the Texas Highway Department giving total VMTs for each Texas county for 1972.
The National average urban VMT breakdown between types of vehicles was used.
Growth was assumed to be

5% until 1980

2% thereafter

DATA SUMMARY FOR N.J. PORTION OF N.Y. - N.J. - CONN. AQCR

I. Emission Rates

A. Motorcycles - Low altitude emission rates were used,

B. Other Vehicles - Low altitude emission rates in AP-42 were used

II. Vehicle Mix By Age

A. Motorcycles - National average values were used.

B. Other Vehicles

1) LDVs - National average values in AP-42 were used.

2) LDTs - Polk data for trucks less than 10,000 lbs in all N.J. Counties in the NY-N.J.-Conn. AQCR were used (1973 Data)

Age	0	1	2	3	4	5	6	7	8	9	10	11	12+
Fraction	.105	.133	.099	.089	.093	.064	.060	.066	.060	.946	.038	.031	.115

3) HDDs & HDGs - Polk Data for trucks more than 10,000 lb. in all counties in the AQCR were used (1973 Data)

Age	0	1	2	3	4	5	6	7	8	9	10	11	12+
Fraction	.078	.108	.080	.098	.102	.078	.067	.080	.062	.050	.041	.033	.123

III Mileage Accumulation Rate By Age

A. Motorcycles. National average values were used.

B. Other Vehicles - National average values in AP-42 were used.

IV. Vehicle Miles Traveled

A. Motorcycles - The following data was used to calculate VMTs:

National average vehicle miles per year values (p 0-3)

Total N.J. motorcycle registrations (D.O.T. Statistics)

Portion of N.J. Population in the N.Y. - N.J. - Conn. AQCR (it was assumed the motorcycle registration would be distributed as the population was distributed: The ratio in 1971 was .71 of N.J. population in N.Y. - N.J. - Conn. AQCR)

National average engine class breakdown future growth rates of:

8% until 1990 (3 motorcycles per 100 people)

4% thereafter

(Since 1970 registrations have increased 8-31% per year)

B. Other Vehicles - VMTs were calculated using the following:

Total auto registrations in J.J. (D.O.T. stas)

% of population in N.Y. - N.J. - Conn AQCR (census)

National average VMT per year per car (AP-42)

National average urban breakdown of VMTs

Among type of vehicles

Growth rate of

2% per year (Guess)

DATA SOURCES FOR LA AQCR ANALYSIS

I. Emission Rates

A. Motorcycles - The basic low altitude values were used.

B. Other Vehicles - The values in AP-42 for California were used.

II. Vehicle Mix By Age

A. Motorcycles - The "Warm Climate" mix was used

B. Other Vehicles - National average values were used (AP-42)

III. Mileage Accumulation Rate By Age

A. Motorcycles - The "Warm Climate" values were used

B. Other Vehicles - National average values were used (AP-42)

IV. Vehicles Miles Traveled

A. Motorcycles - The following data were used to calculate VMTs: Total registrations in LA AQCR (From EPA paper by T. Comfort). National average engine class mix, warm climate average mileage accumulation rates, and an assumed growth rate of 2%.

B. Other Vehicles - The following data were used to calculate VMT's: Total VMTs in LA AQCR (From "Transportation Control Strategy Development for the Metropolitan Los Angeles Region", APTD - 1372, Dec. 1972, p 98) fraction of VMT's by M. Williams; growth rates as indicated in the above EPA report.

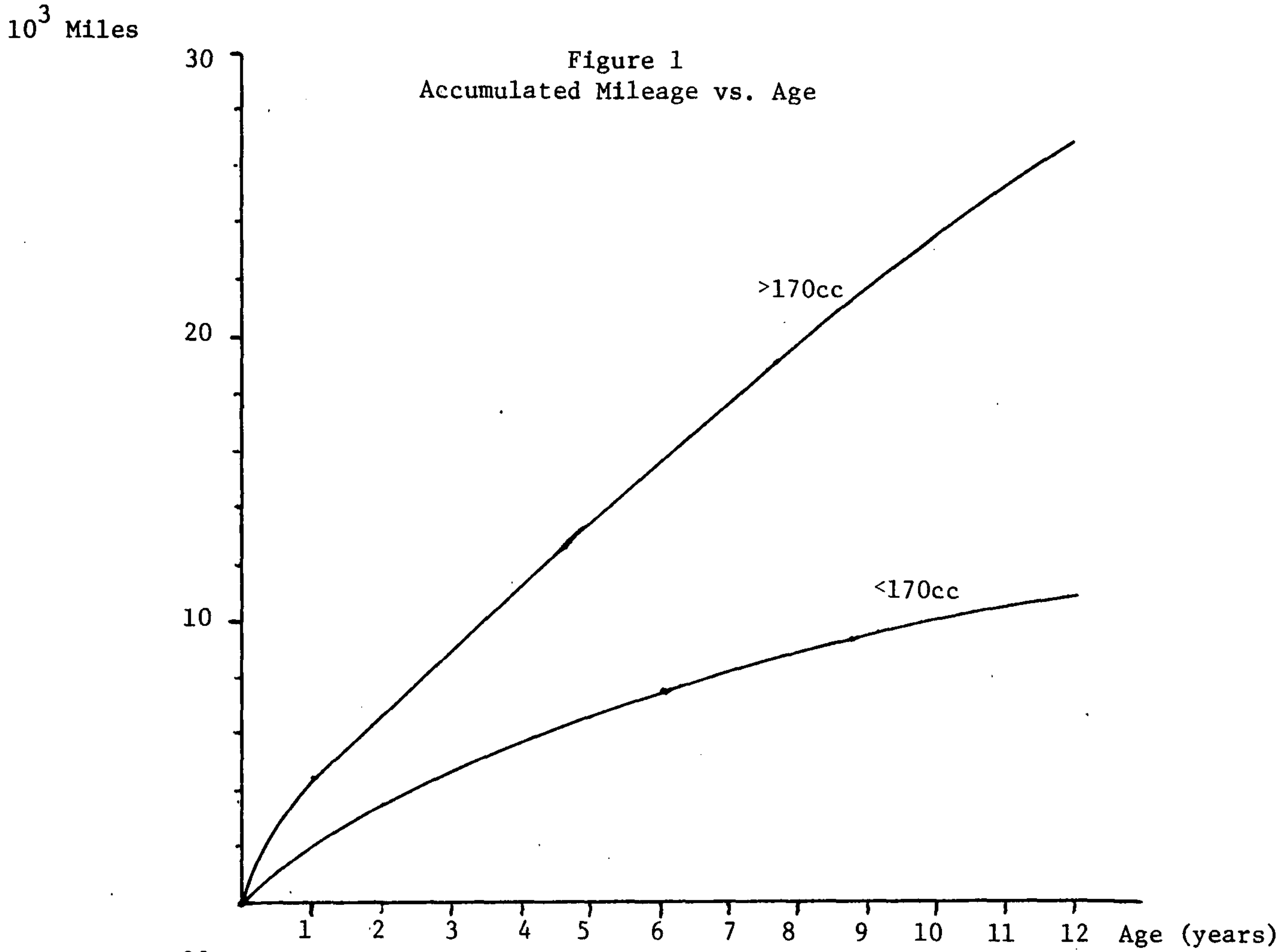


Figure 1
Accumulated Mileage vs. Age

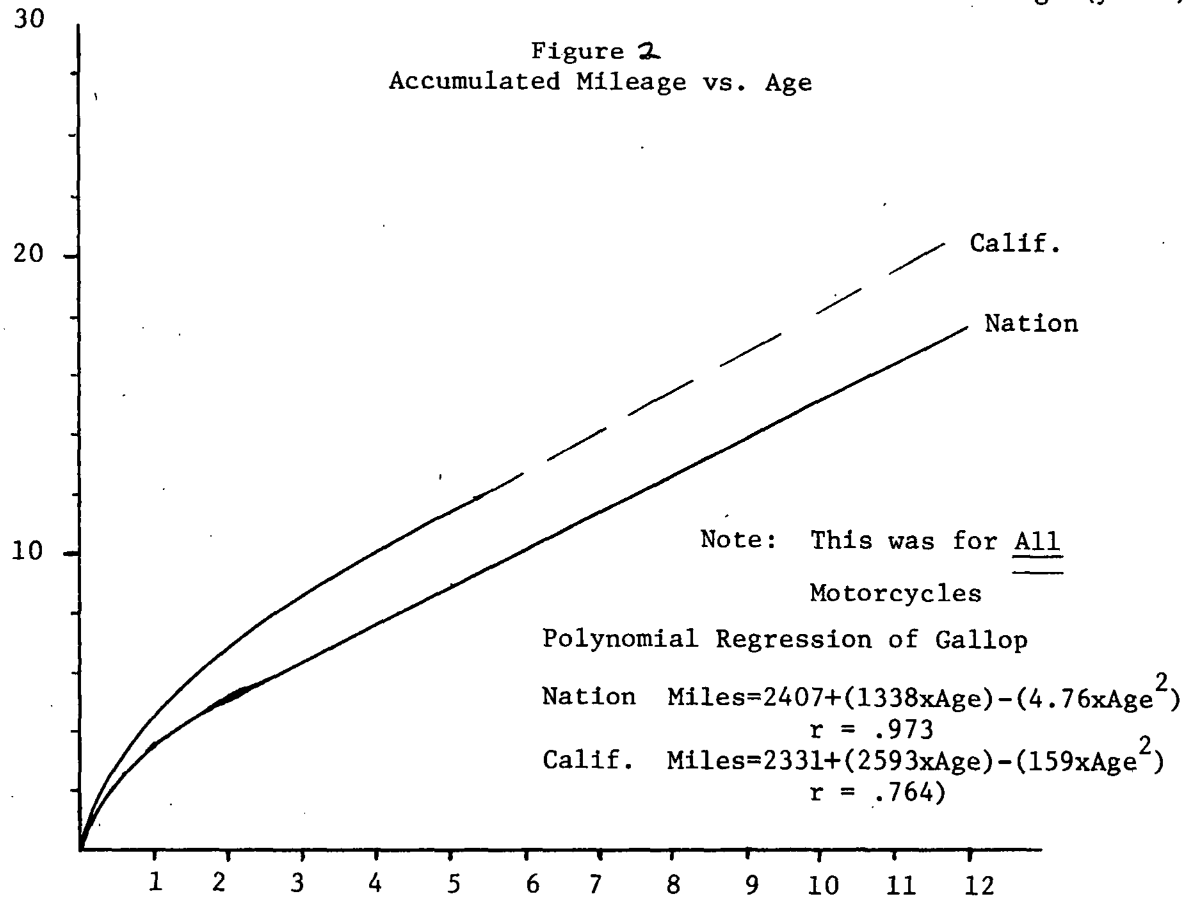
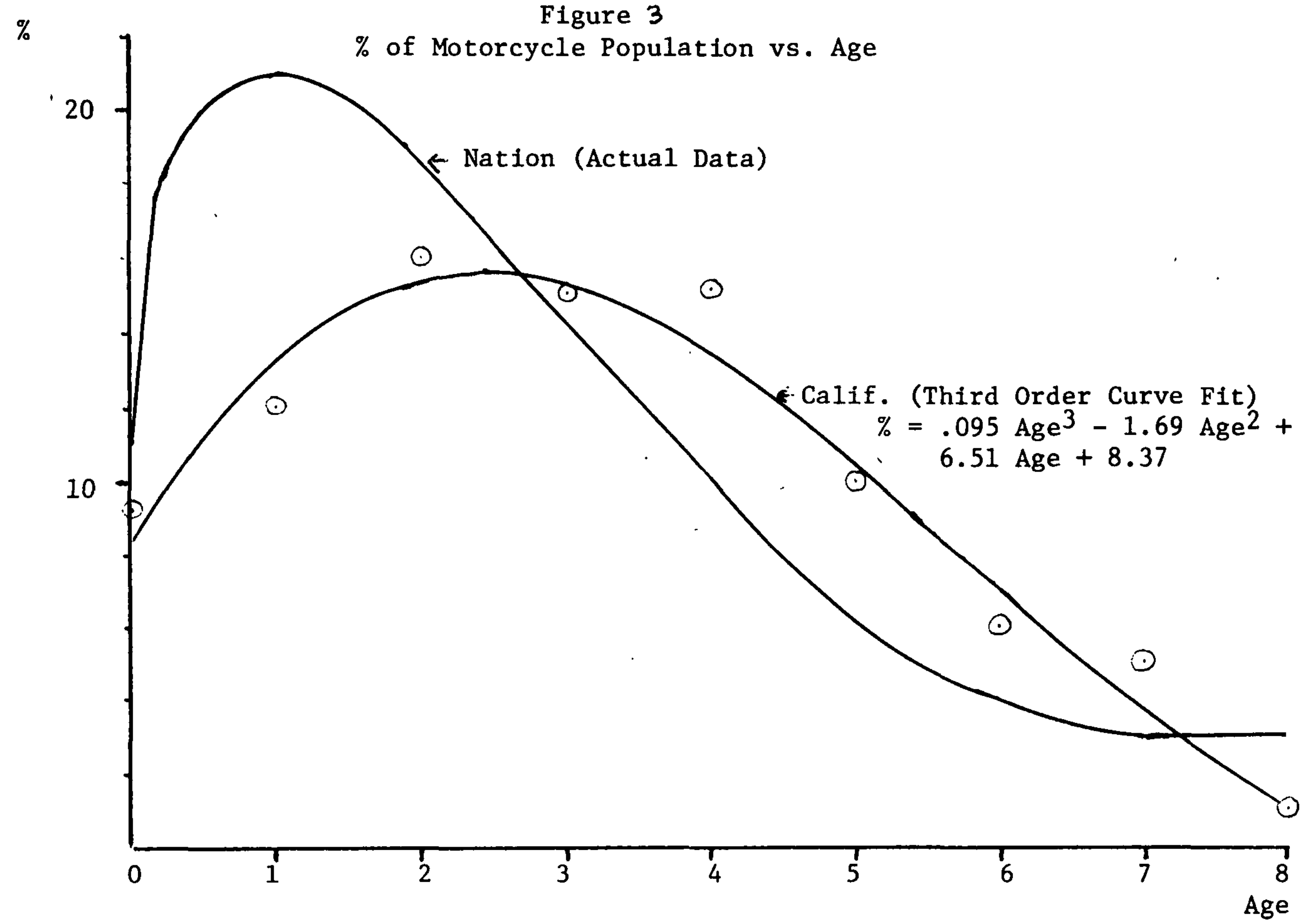


Figure 2
Accumulated Mileage vs. Age

Figure 3

% of Motorcycle Population vs. Age



Appendix 2

Motorcycle Emission Inventory
Graphical Representation

Figure 2-1
Projected Nationwide Hydrocarbon Exhaust
Emissions for Motorcycles

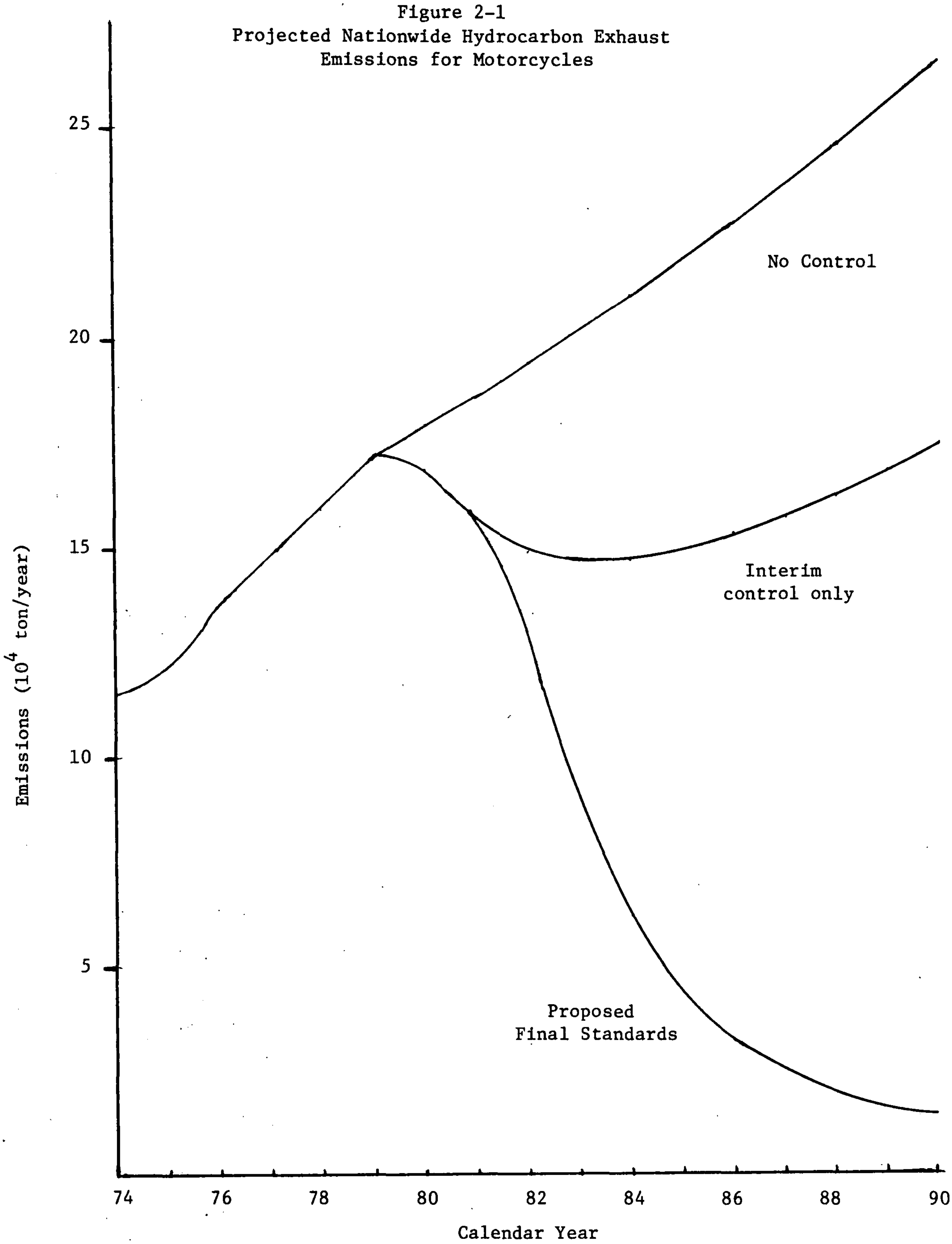
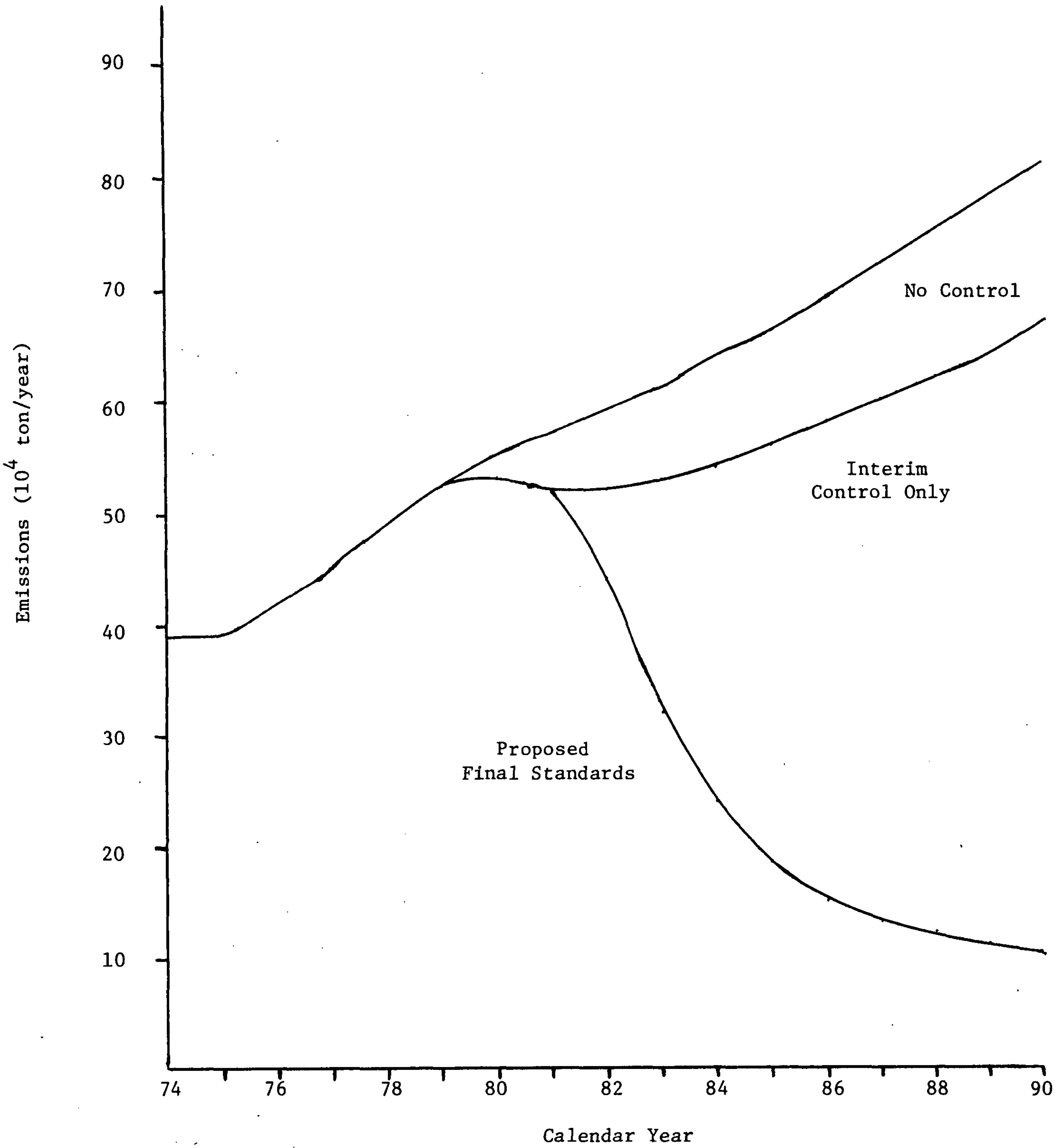


Figure 2-2
Projected Nationwide Carbon Monoxide
Emissions for Motorcycles



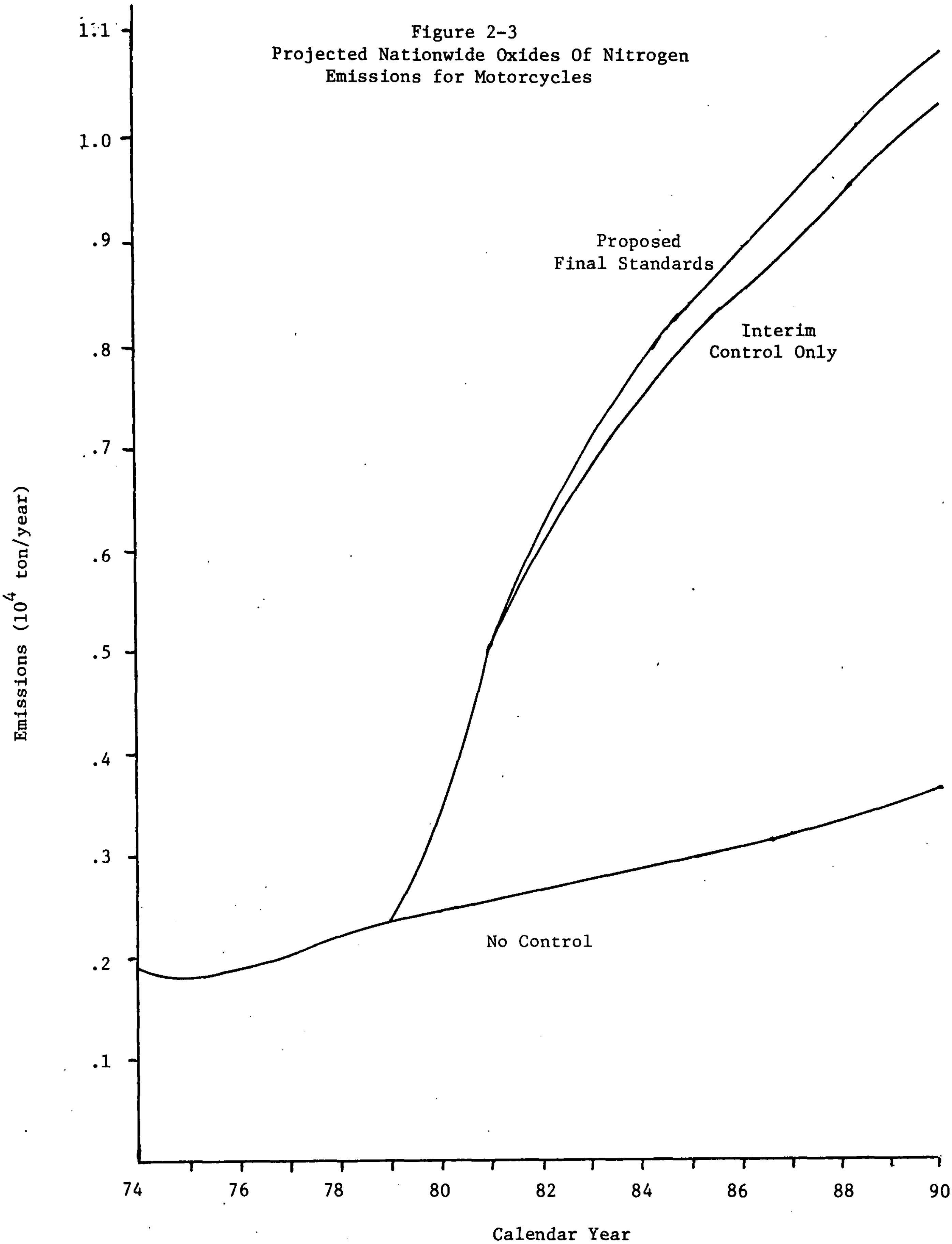


Figure 2-3
Projected Nationwide Oxides Of Nitrogen
Emissions for Motorcycles
Proposed
Final Standards
Interim
Control Only
No Control
Emissions (10^4 ton/year)
Calendar Year
1.1
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
74
76
78
80
82
84
86
88
90

Figure 2-4
Projected Los Angeles AQCR
Hydrocarbon Exhaust Emissions for Motorcycles

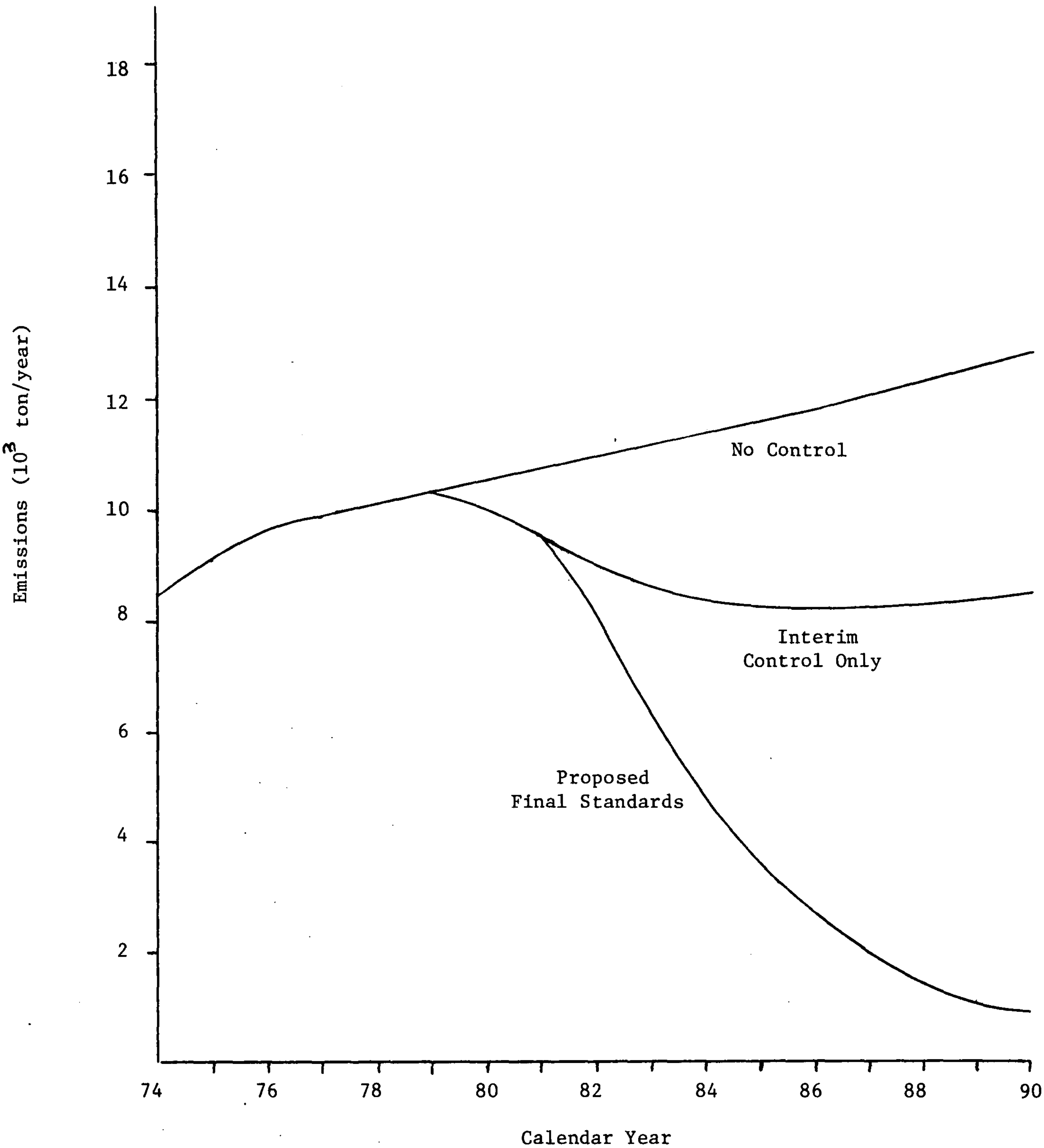


Figure 2-5
Projected Los Angeles AQCR
Carbon Monoxide Emissions for Motorcycles

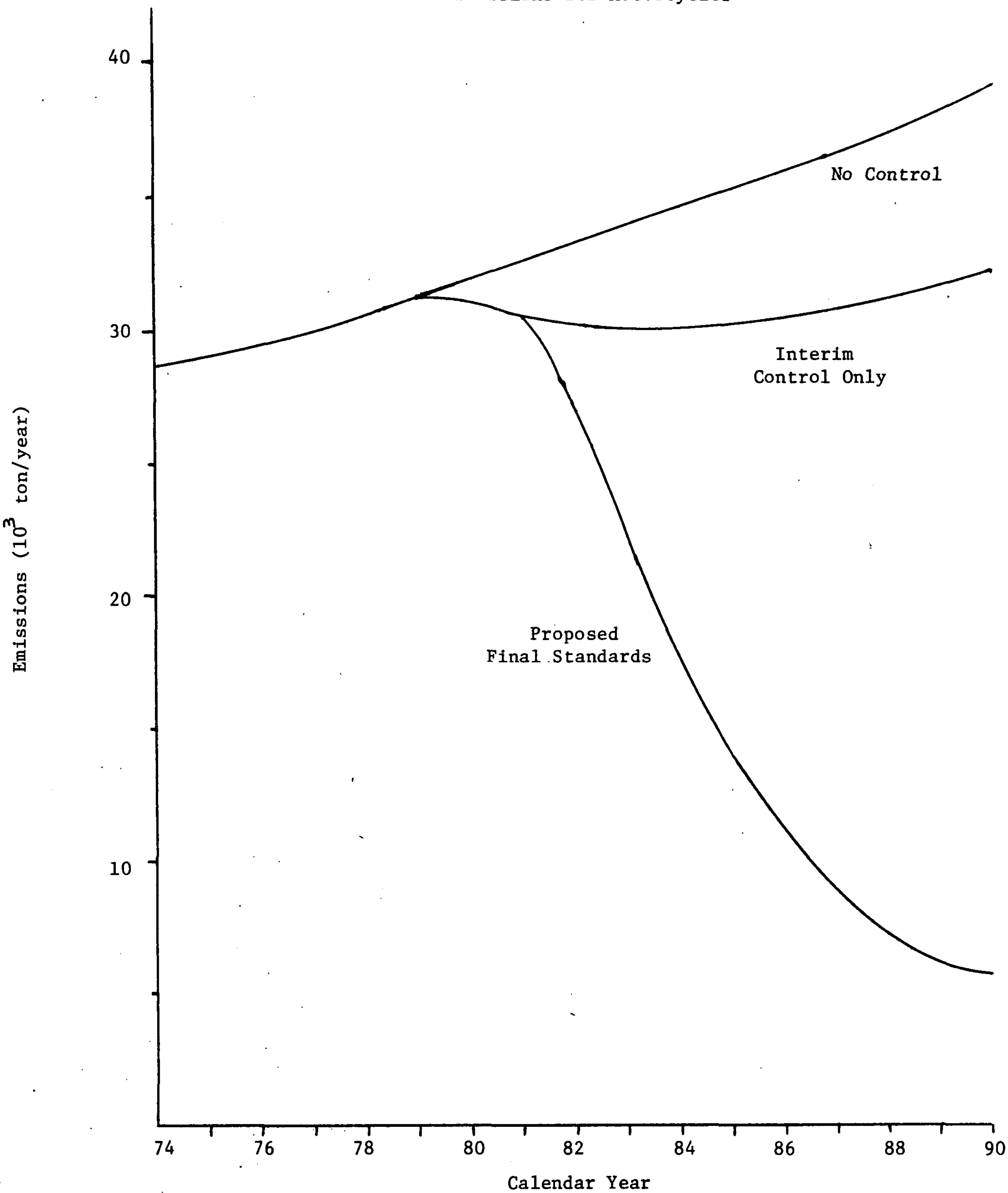
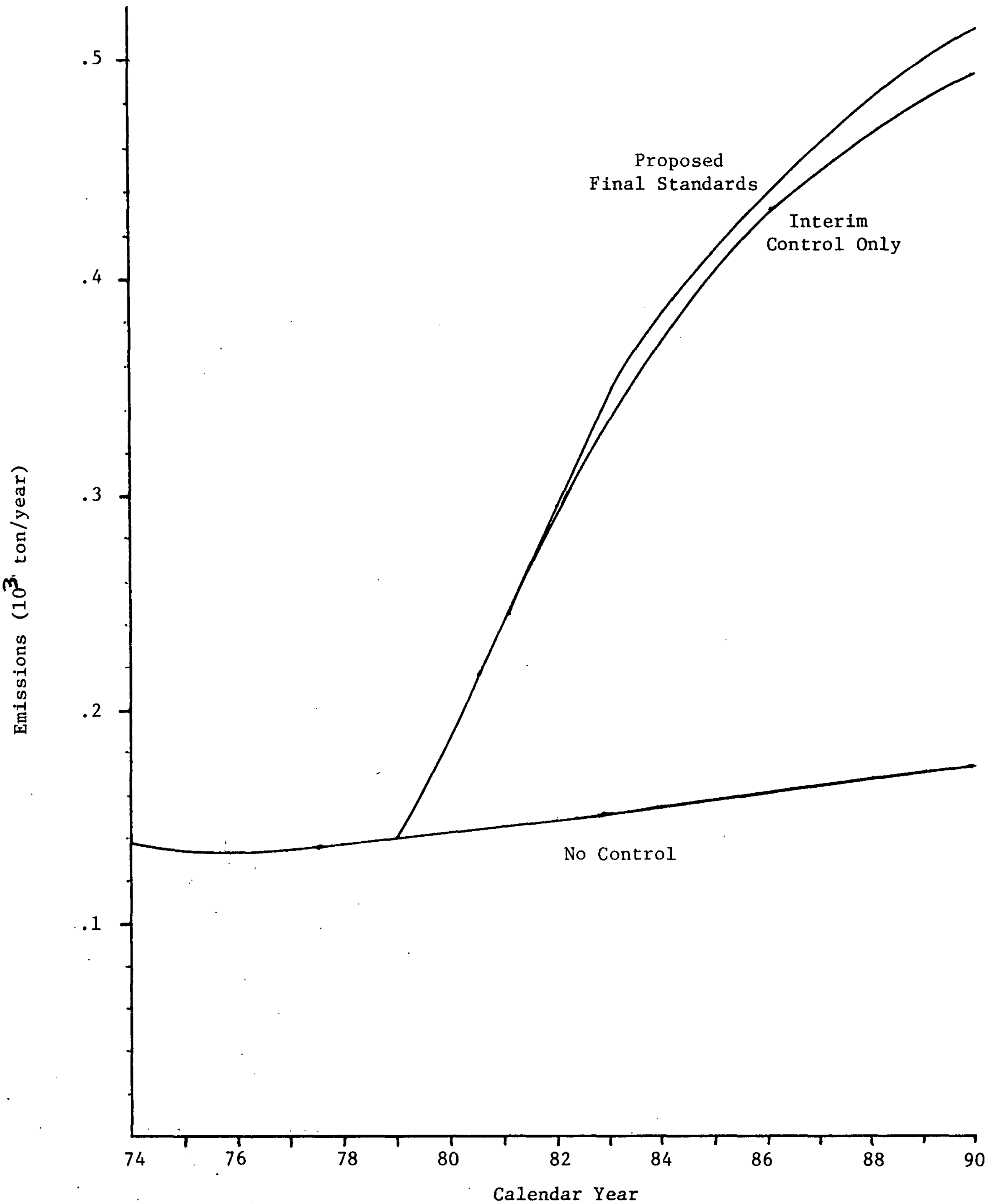


Figure 2-6
Projected Los Angeles AQCR
Oxides of Nitrogen Emissions for Motorcycles



Appendix 3

Motorcycle Emissions as a Percent of Standard

Appendix 3
Motorcycle Emissions as a Percent of Standard

In order to calculate motorcycle emissions in 1990 as a percent of the emissions allowable if the standard is to be met, it is necessary to determine the allowable emissions at the standard. The following proportion is used:

$$\frac{\text{1970 ambient concentration}}{\text{ambient standard}} = \frac{\text{1970 emission factor}}{x}$$

where x is the total allowable emissions, mobile and stationary, if the standard is to be met. Solving for x,

$$x = \text{1970 emission factor} \left(\frac{\text{1970 ambient concentration}}{\text{ambient standard}}\right).$$

The 1970 emission factor, in tons, should be the sum of the mobile and stationary 1970 emissions in tons (or equivalent units). Since stationary emission factors were not readily available, the following identity was used:

$$\text{1970 emission factor} = \frac{\text{1970 mobile emission factor}}{\text{\% mobile source contribution}},$$

The % of the total 1970 emissions attributed to mobile sources has been supplied by Office of Air Quality Planning and Standards.

Data needed to comput the value of x is given below for selected regions:

	HC		CO	
	Percent Mobile	Concentration (ppm)	Percent Mobile	Concentration (ppm)
Pheonix	49	.19	99	42
Denver	81	.28	99	33
New York/New Jersey	73	.26	99	51
Houston	41	.32	--	--
Los Angeles	69	.62	99	41
Salt Lake City	--	--	98	41
Ambient Standard		.08		9

The uncontrolled motorcycle contribution as a percent of the allowable emissions in 1990 is:

$$\frac{\text{1990 motorcycle emissions}}{x}$$

The following table presents the motorcycle percentage contribution to the allowable emissions at standard for selected regions.

Percent Allowable Emissions
Contributed by Uncontrolled Motorcycles in 1990

Region	HC*	CO
Pheonix	3%	5%
Salt Lake City	-	7%
Denver	8%	4%
Houston	4%	-
New Jersey	3%	3%
Los Angeles	12%	4%

*This analysis considers total hydrocarbons, reactive and non-reactive. The analysis has not considered reactive hydrocarbons only since the definition of what is reactive is highly variable. Only methane is generally agreed upon as being totally non-reactive. Other light hydrocarbons such as ethane, butane, and acetylene may be reactive with enough time. If stationary sources and/or light duty vehicles and trucks have significant portions of methane in their emissions, motorcycles could contribute an even greater percentage of total allowable emissions if the standard is to be met. Motorcycle HC emissions are essentially one hundred percent reactive.