ENVIRONMENTAL PROTECTION AGENCY

REGION IX

100 CALIFORNIA STREET
SAN FRANCISCO, CA 94111

JANUARY 15, 1973

TECHNICAL SUPPORT DOCUMENT

FOR THE METROPOLITAN LOS ANGELES

INTRASTATE AIR QUALITY CONTROL REGION

SUMMARY

This technical document consists of three Sections:

1. Control Strategy Package--
   An evaluation of emissions in 1970 and 1977 with and without various additional control measures.

2. Standards versus VMT reduction--
   An evaluation of the effect of changing the oxidant standard on the severity of the VMT reductions.

3. Future Emissions in the Metropolitan Los Angeles Intrastate AQCR.

The information contained in this document served the primary purpose of presenting the severity of the problem in the South Coast Air Basin (Metropolitan Los Angeles Intrastate AQCR). It by no means discusses all the alternatives available in achieving the National Ambient Air Quality Standard for photochemical oxidant.

Any technical comments on the evaluation presented here are welcomed. Any persons having such comments should send them to the U.S. Environmental Protection Agency, Region IX, Division of Air and Water Programs, 100 California Street, San Francisco, California 94111.

CONTROL STRATEGY PACKAGE
TO CONTROL HIGH REACTIVE HYDROCARBONS
TO MEET .08 OXIDANT STANDARD
IN SOUTH COAST AIR BASIN
BY JUNE 30, 1977

January 10, 1973

I. Determination of Maximum Allowable High Reactive Hydrocarbon Emissions to Meet .08 ppm 1-hour Oxidant Standard.

The oxidant control strategy discussed in this report involves the control of high reactive hydrocarbons (hydrocarbons and other organic gases) as defined by Los Angeles type APCD Rules 10, 56, 57, 58, 59, 61, 65, and 66 for stationary sources (6), and by California Institute of Technology referenced reactivity factors (2) for gasoline vehicle emissions. This inventory and general control approach was used in the State Air Implementation Plan, and has been tentatively accepted by EPA. As a result of this approach, some hydrocarbons considered to be reactive by EPA, are not considered in this control strategy.

The yearly high 1-hour ambient oxidant reading for a given day is considered to be directly proportional to the amount of high reactive hydrocarbon emissions for that day. In other words, a straight line proportionality is assumed to exist between the ambient oxidant reading and the high reactive hydrocarbon inventory. Straight line proportional roll back of high reactive hydrocarbon emissions is then used to predict the emissions reduction needed to meet the oxidant standard.

The base year of 1970 is used to make this prediction. On August 6, 1970, the yearly 1-hour high oxidant reading of .62 ppm was recorded at Riverside. The .67 ppm year high oxidant reading used by the California Air Resources Board (ARB) in the air implementation plan has since been rejected by the ARB. The State Plan showed a total of 195 tons/day of stationary source high reactive hydrocarbon emission, and 33 tons/day from aircraft in 1970. The 1970 emissions from other mobile sources (i.e., on-highway light and heavy duty gasoline vehicles and motorcycles) are calculated in appendix A, and these emissions are 1023 tons/day. As indicated, this number does not include the emissions from off-highway gasoline usage. However, this usage is considered negligible on the basis of data obtained from the ARB staff, which showed that current off-highway gasoline usage accounts for only slightly more than 2% of gasoline sales.

Based on the federal .08 ppm maximum 1-hour oxidant standard, the 1970 high 1-hour ambient oxidant reading of .62 ppm, and the 1970 emissions inventory just discussed, the allowable high reactive hydrocarbon emissions are determined as follows:

$$(195+33+1023)\ \frac{.08}{.62} = 161 \text{ tons/day}$$

II. Outline of the Control Strategy Package to Meet the Federal .08 ppm 1-hour Oxidant Standard by July 1977: (Per Appendices B, C, D, and E)

The strategies discussed in this package include those for which it was felt that sufficient information existed to claim or estimate emissions reductions. The exceptions to this are the Vehicle Miles Travelled (VMT) reduction strategies evaluated by TRW and its subcontractor, De Leuw Cather (7). No VMT reductions are claimed in this report from these measures. Any VMT reduction that these strategies might produce, would lessen the amount of gas rationing that would be needed as a final last resort measure to meet the standard.

Aircraft emissions and their control are based on the State Plan emission inventory and an EPA estimate of 30% aircraft emissions reductions determined as a result of conversations with EPA personnel. These emissions in 1977 are calculated to be

$$35 \times .7 = 24 \text{ tons/day}$$

The June 1977 emissions from light and heavy duty vehicles and motorcycles, when taking into account only the emissions reduction that would result from present and proposed factory installed control devices, are determined in Appendix B. Using these emissions as a basline in Appendix C, control strategies are applied to various segments of the light and heavy duty vehicle population and the resulting emissions reductions are calculated. Gas rationing is the final strategy that is evaluated, and is used as a last resort to attain the standard. Gas rationing not only affects the emissions from vehicular sources, but also affects the emissions from gasoline marketing operations. This is discussed and reflected in the calculations of Appendices C and D. Appendix D contains the evaluation and discussion of stationary source control strategies.

A compilation of the strategies and their step by step reductions are shown in the following Table 1. The emissions reductions that are shown for each mobile control strategy b. thru g., are the reductions that can be expected by the addition of each strategy only after the strategies listed prior to it have been implemented. In other words, the emissions reductions are determined from an emissions base that has been altered by the strategies previously evaluated. As a result of this then, the reductions in ton/day of one strategy cannot be compared to the reductions obtained by another strategy because the emissions base is altered (i.e., lowered) after each strategy is applied.

Table 2 shows the normalized emissions reductions that should be actually related to each strategy. The calculations and discussion involved in this weighting approach are found in Appendix E.

TABLE 1

Compilation of Non-Normalized Control Strategy Effects (Per Appendices C and D)

On June 30, 1977

	Tons/day
Allowable Emissions	+ 161
Stationary source emissions (not including gasoline marketing)	+ 140
Stationary Control Strategy Reductions:	
a. Dry cleaning vapor recovery	- 6
b. Degreaser substitute	- 25
c. Additional Stationary Control Rule strengthening	- 45
Stationary Emissions Remaining	+ 64
Motorcycle Emissions (not controlled)	+ 30
Aircraft Emissions	+ 35
a. Aircraft emissions reductions	- 11
Motorcycle & Aircraft Emissions Remaining	+ 54
Mobile emissions from on-highway light and heavy duty vehicles, and from gasoline marketing operations	+ 486
Mobile Control Strategy Reductions	
a. VSAD & PVD retrofit program	- 19
b. Inspection and maintenance	- 39
c. Vehicle evaporative control retrofit	- 26
d. Gaseous fuel conversion	- 12
e. Oxidizing catalyst retrofit	- 84
f. Gas rationing	- 251
g. Gasoline marketing vapor control	- 12
Mobile Emissions Remaining	+ 43
Total Emissions Remaining	+ 161

TABLE 2

Compilation of Normalized Control Strategy Effects
(Per Appendix E)

On June 30, 1977

	Tons/day
Allowable Emissions	+ 161
Stationary source emissions (not including gasoline marketing)	+ 140
Stationary Control Strategy Reductions:	
a. Dry cleaning vapor recovery	- 6
b. Degreaser substitute	- 25
c. Additional Stationary Control Rule strengthening	- 45
Stationary Emissions Remaining	+ 64
Motorcycle Emissions (not controlled)	+ 30
Aircraft Emissions	+ 35
a. Aircraft emissions reductions	- 11
Motorcycle & Aircraft Emissions Remaining	+ 54
Mobile emissions from on-highway light and heavy duty vehicles, and from gasoline marketing operations	+ 486
Mobile Control Strategy Reductions	
a. VSAD & PCV retrofit program	- 13
b. Inspection and maintenance	- 28
c. Vehicle evaporative control retrofit	- 19
d. Gaseous fuel conversion	- 8
e. Oxidizing catalyst retrofit	- 70
f. Gas rationing	- 269
g. Gasoline marketing vapor control	- 37
Mobile Emissions Remaining	- 42
Total Emissions Remaining	+ 160

III Discussion of Control Strategy and Relative Importance of Emission Sources:

The control strategy package previously discussed in Section II employs some strategy applications and reduction factors that are not justified on the basis of Ref. 4. (These are discussed briefly in the footnotes in the appropriate sections of Appendix C.) This is the case with regard to heavy duty vehicle exhaust emissions, and the control of these emissions by inspection and maintenance and oxidizing catalyst retrofit strategies. It was felt, however, that it was not unreasonable to expect that these strategies could be implemented by 1977; and based on the fact that the uncontrolled heavy duty exhaust emissions (Ref. Appendix B) are (73.19/272.2 = .37) of the light duty vehicle exhaust emissions in 1977, it was considered necessary to apply these two strategies, even though rough estimates had to be used to determine the strategy effects. These two strategies as applied to heavy duty vehicles in this control package, account for normalized reductions of 21.69 tons/day (See Appendix E, Section b, under Calculations).

Motorcycle emissions in 1977 contribute 30 tons/day (a disproportionate amount of emissions), and some controls on these vehicles should be seriously considered. Two stroke motorcycles, which comprise only 38% of the motorcycle population, contribute 69% of the 30 tons/day (See Appendix B), and deserve special attention for control considerations, including possibly a complete ban on these vehicles. If severe gasoline consuption restrictions were placed on the South Coast Air Basin, it could be expected that the motorcycle population and the miles traveled per vehicle year would drastically increase. Only a normal "miles traveled per vehicle year" figure, and vehicle population growth rate are reflected in the predicted motorcycle emissions for 1977.

A simplifying assumption is made in Appendix C, which equates a given percentage reduction in gasoline consumption (i.e. gas rationing) to an equal reduction in VMT. In reality it should be expected that under gas rationing conditions people would drive more miles with vehicles that would produce better gas mileage, such as compact economy cars, thus producing more VMT and emissions than is calculated based on the simplifying assumption. Therefore, the effects of any gas rationing program would in reality have to be evaluated by actually measuring the affects of the rationing on VMT reduction, and using this relationship to attempt to model or predict the affect of additional rationing on VMT during the next gas rationing season. It is anticipated that gas rationing would be in affect during only the high potential photochemical smog season of approximately May through October.

APPENDIX A

Dec. 31, 1970 South Coast Air Basin
On-Highway Gasoline Vehicle
High Reactive Hydrocarbon Emission Inventory

This appendix details the information and calculations involved in determining this emission inventory for light and heavy duty gasoline-powered motor vehicles and 2 and 4 stroke motorcycles.

The following data were obtained from the California Department of Motor Vehicles (DMV), the California Highway Patrol, and the California Air Resources Board (ARB), and were supplied to EPA by the ARB:

Average vehicle age
Age distribution
Vehicle population and population fraction
Miles driven per vehicle year

The emission factors and deterioration factors are from the EPA draft report "Interim Report On Motor Vehicle Emission Estimation." (1) The reactivity factors (i.e., fraction of hydrocarbon vapor that is highly reactive per LAAPCD inventory) for gasoline exhaust and gasoline evaporative and crankcase emission are obtained from the California Institute of Technology - Environmental Quality Laboratory Report "SMOG a Report to the People." (2) The miles traveled per vehicle year for heavy duty vehicles are obtained from the publication "1971 Motor Truck Facts." (3) The motorcycle emission factors were obtained verbally from EPA sources, Armstrong and Kircher.

The age distribution for heavy duty vehicles is assumed to be the same as that for light duty vehicles.

The vehicle population in the South Coast Air Basin on December 31, 1970 is estimated by multiplying the 1970 state-wide vehicle population by the 1970 South Coast Basin fraction of state-wide population. The light duty vehicle population for the basin is calculated as follows:

11,250,000 x .4972 = 5,600,000

The Basin heavy duty vehicle population is calculated as follows:

466,300 x .4972 = 233,000

The Basin motorcycle population is calculated as follows:

568,500 x .4972 = 283,000

2-stroke motorcycles constitute 38% of the population, and 4-stroke motorcycles make up the remainder.

TABLE A-1

December 31, 1970

LIGHT DUTY GASOLINE VEHICLE HIGH REACTIVE HYDROCARBON EXHAUST EMISSION INVENTORY

Model Year	Average Age(yr.)	Vehicle Age Distribution	Total Basin Vehicle Population	Miles Driven Per Vehicle Year	Low Mileage Emission Factor (gm./mi)	Age Deterior-ation Factor	Conversion Factor (ton-yr.)/(gm.-day)	Reactivity Factor	Emissio (ton)/(day)
1971	1/8	.023	5.6×10^6	2,000	2.9	1.01	3.02×10^{-9}	.8	1.8
1970	3/4	.090	5.6×10^6	11,600	3.6	1.04	3.02×10^{-9}	.8	52.9
1969	1 3/4	.106	5.6×10^6	11,500	4.4	1.15	3.02×10^{-9}	.8	83.5
1968	2 3/4	.0971	5.6×10^6	10,200	4.5	1.21	3.02×10^{-9}	.8	73.0
1967	3 3/4	.0847	5.6×10^6	9,000	4.6	1.14	3.02×10^{-9}	.8	54.1
1966	4 3/4	.0898	5.6×10^6	7,700	6.0	1.29	3.02×10^{-9}	.8	72.4
1965	5 3/4	.0948	5.6×10^6	7,000	8.8	1.00	3.02×10^{-9}	.8	79.0
1964	6 3/4	.0838	5.6×10^6	6,000	8.8	1.00	3.02×10^{-9}	.8	59.9
1963	7 3/4	.0723	5.6×10^6	5,000	8.8	1.00	3.02×10^{-9}	.8	43.0
1962	8 3/4	.0597	5.6×10^6	4,400	8.8	1.00	3.02×10^{-9}	.8	31.3
1961	9 3/4	.0409	5.6×10^6	3,900	8.8	1.00	3.02×10^{-9}	.8	19.0
1960	10 3/4	.0367	5.6×10^6	3,800	8.8	1.00	3.02×10^{-9}	.8	16.6
1959 & earlier	11 3/4+	.1212	5.6×10^6	3,300	8.8	1.00	3.02×10^{-9}	.8	47.6
								Total	634.1

TABLE A-2

December 31, 1970

Light Duty Gasoline Vehicle High Reactive Hydrocarbon
Crankcase and Evaporative Emission Inventory

Model Year	Age Distribution	Total Basin Vehicle Population	Miles Driven Per Vehicle Year	Emission Factor (gm/mi)	Conversion Factor (Ton/yr.) (gm/day)	Reactivity Factor	Emissions (Tons/day)
1971	.023	5.6×10^6	2,000	.5	3.02×10^{-9}	.67	.3
1970	.090	5.6×10^6	11,600	.5	3.02×10^{-9}	.67	5.9
1969	.106	5.6×10^6	11,500	3.0	3.02×10^{-9}	.67	41.4
1968	.0971	5.6×10^6	10,200	3.0	3.02×10^{-9}	.67	33.7
1967	.0847	5.6×10^6	9,000	3.0	3.02×10^{-9}	.67	25.9
1966	.0898	5.6×10^6	7,700	3.0	3.02×10^{-9}	.67	23.5
1965	.0948	5.6×10^6	7,000	3.0	3.02×10^{-9}	.67	22.6
1964	.0838	5.6×10^6	6,000	3.0	3.02×10^{-9}	.67	17.1
1963	.0723	5.6×10^6	5,000	3.8	3.02×10^{-9}	.67	15.6
1962	.0597	5.6×10^6	4,400	3.8	3.02×10^{-9}	.67	11.3
1961	.0409	5.6×10^6	3,900	3.8	3.02×10^{-9}	.67	6.9
1960	.0367	5.6×10^6	3,800	7.1	3.02×10^{-9}	.67	11.2
1959 & earlier	.1212	5.6×10^6	3.300	7.1	3.02×10^{-9}	.67	32.2
						Total	247.6

TABLE A-3

December 31, 1970

HEAVY DUTY GASOLINE VEHICLE HIGH REACTIVE HYDROCARBON EXHAUST EMISSION INVENTORY

Model Year	Average Age(yr.)	Vehicle Age Distribution	Total Basin Vehicle Population	Miles Driven Per Vehicle Year	Low Mileage Emission Factor (gm./mi)	Age* Deterioration Factor	Conversion Factor (ton-yr.)/(gm.-day)	Reactivity Factor	Emission (ton)/(day)
1971	1/8	.023	2.32×10^5	1,300	15	1.02	3.02×10^{-9}	.8	.3
1970	3/4	.090	2.32×10^5	7,500	15	1.09	3.02×10^{-9}	.8	6.2
1969	1 3/4	.106	2.32×10^5	10,000	19	1.00	3.02×10^{-9}	.8	11.3
1968	2 3/4	.0971	2.32×10^5	10,000	19	1.00	3.02×10^{-9}	.8	10.3
1967	3 3/4	.0847	2.32×10^5	10,000	19	1.00	3.02×10^{-9}	.8	9.0
1966	4 3/4	.0898	2.32×10^5	10,000	19	1.00	3.02×10^{-9}	.8	9.6
1965	5 3/4	.0948	2.32×10^5	10,000	19	1.00	3.02×10^{-9}	.8	10.1
1964	6 3/4	.0838	2.32×10^5	10,000	19	1.00	3.02×10^{-9}	.8	8.9
1963	7 3/4	.0723	2.32×10^5	10,000	19	1.00	3.02×10^{-9}	.8	7.7
1962	8 3/4	.0597	2.32×10^5	10,000	19	1.00	3.02×10^{-9}	.8	6.4
1961	9 3/4	.0409	2.32×10^5	10,000	19	1.00	3.02×10^{-9}	.8	4.4
1960	10 3/4	.0367	2.32×10^5	10,000	19	1.00	3.02×10^{-9}	.8	3.9
1959 & earlier	11 3/4+	.1212	2.32×10^5	10,000	19	1.00	3.02×10^{-9}	.8	12.9
								Total	101.0

*Based on recommendation of EPA interim emission factor report, Pg. 8(1)

TABLE A-4

December 31, 1970

Heavy Duty Gasoline Vehicle High Reactive Hydrocarbon Crankcase and Evaporative Emission Inventory

Model Year	Age Distribution	Total Basin Vehicle Population	Miles Driven Per Vehicle Year	Emission Factor (gm/mi)	Conversion Factor (Ton/yr.) (gm/day)	Reactivity Factor	Emissions (Tons/day)
1971	.023	2.32×10^5	1,300	3.0	3.02×10^{-9}	.67	.04
1970	.090	2.32×10^5	7,500	3.0	3.02×10^{-9}	.67	.95
1969	.106	2.32×10^5	10,000	3.0	3.02×10^{-9}	.67	1.49
1968	.0971	2.32×10^5	10,000	3.0	3.02×10^{-9}	.67	1.37
1967	.0847	2.32×10^5	10,000	3.0	3.02×10^{-9}	.67	1.19
1966	.0898	2.32×10^5	10,000	3.0	3.02×10^{-9}	.67	1.26
1965	.0948	2.32×10^5	10,000	3.0	3.02×10^{-9}	.67	1.34
1964	.0838	2.32×10^5	10,000	3.0	3.02×10^{-9}	.67	1.18
1963	.0723	2.32×10^5	10,000	3.8	3.02×10^{-9}	.67	1.29
1962	.0597	2.32×10^5	10,000	3.8	3.02×10^{-9}	.67	1.06
1961	.0409	2.32×10^5	10,000	3.8	3.02×10^{-9}	.67	.73
1960	.0367	2.32×10^5	10,000	8.2	3.02×10^{-9}	.67	1.41
1959 & earlier	.1212	2.32×10^5	10,000	8.2	3.02×10^{-9}	.67	4.67
						Total	17.98

TABLE A-5

December 31, 1970

2 Stroke Motorcycle Reactive Hydrocarbon Exhaust Emission Inventory

Vehicle Population	Miles Driven Per Vehicle Year	Emission Factor (gm/mi)	Conversion Factor (ton-yr)/(gm-day)	Reactivity Factor	Emissions Ton/Day
107,500	3,900	15	3.02×10^{-9}	.8	15.2

TABLE A-6

December 31, 1970

4 Stroke Motorcycle Reactive Hydrocarbon Exhaust Emission Inventory

Vehicle Population	Miles Driven Per Vehicle Year	Emission Factor (gm/mi)	Conversion Factor (ton-yr)/(gm-day)	Reactivity Factor	Emissions Ton/Day
175,500	3,900	3.3	3.02×10^{-9}	.8	5.5

TABLE A-7

December 31, 1970

4 Stroke Motorcycle Reactive Hydrocarbon
Crankcase Emission Inventory

Vehicle Population	Miles Driven Per Vehicle Year	Emission Factor (gm/mi)	Conversion Factor (ton-yr)/(gm-day)	Reactivity Factor	Emissions Ton/Day
175,500	3,900	.7	3.02×10^{-9}	.67	1.0

TABLE A-8

December 31, 1970

2 Stroke Motorcycle Reactive Hydrocarbon
Evaporative Emission Inventory

Vehicle Population	Miles Driven Per Vehicle Year	Emission Factor (gm/mi)	Conversion Factor (ton-yr)/(gm-day)	Reactivity Factor	Emissions Ton/Day
107,500	3,900	.32	3.02×10^{-9}	.67	.3

TABLE A-9

December 31, 1970

4 Stroke Motorcycle Reactive Hydrocarbon
Evaporative Emission Inventory

Vehicle Population	Miles Driven Per Vehicle Year	Emission Factor (gm/mi)	Conversion Factor (ton-yr)/(gm-day)	Reactivity Factor	Emissions Ton/Day
175,500	3,900	.35	3.02×10^{-9}	.67	.5

APPENDIX B

June 30, 1977 South Coast Air Basin
On-Highway Gasoline Vehicle
High Reactive Hydrocarbon Emission Inventory

(Based on the emissions control produced by new car
(i.e., factory installed) emission control devices)

This appendix details the information and calculations involved in determining this emission inventory for light and heavy duty gasoline powered motor vehicles and 2 and 4 stroke motorcycles.

The following data were obtained from the California Department of Motor Vehicles (DMV), the California Highway Patrol, and the California Air Resources Board (ARB), and were supplied to EPA by the ARB:

Average vehicle age
Age distribution
Vehicle population and population fraction
Miles driven per vehicle year
Population growth factor

The emission factors and deterioration factors are from the EPA draft report "Interim Report On Motor Vehicle Emission Estimation." (1) The reactivity factors (i.e., fraction of hydrocarbon vapor that is highly reactive per Los Angeles Air Pollution Control District inventory) for gasoline exhaust and gasoline evaporative and crankcase emission are obtained from the California Institute of Technology - Environmental Quality Laboratory Report "SMOG A Report to the People." (2) The miles traveled per vehicle year for heavy duty vehicles are obtained from the publication "1971 Motor Truck Facts." (3) The motorcycle emission factors were obtained verbally from EPA sources, Armstrong and Kircher.

The age distribution for heavy duty vehicles is assumed to be the same as that for light duty vehicles.

The vehicle population in the South Coast Air Basin on June 30, 1977 is estimated by multiplying the statewide vehicle population in 1970 by a population growth factor that is adjusted to reflect the June 30 inventory date. This product is then multiplied by the adjusted 1977 South Coast Air Basin fraction of statewide vehicle population. The calculation for determining the light duty vehicle population in the Basin on June 30, 1977 is shown below.

1970 Statewide Vehicle Population x [1 + 1970 to 77 Growth Factor x (June 77/Dec. 77) adjustment] x South Coast Basin Vehicle Population Fraction = Basin Vehicle Population

$$11{,}250{,}000 \left(1 + .104 \times \frac{6.5}{7}\right) \ .4918 = 6{,}070{,}000$$

The vehicle age distribution was adjusted to reflect the June 30 inventory by eliminating the .023 fraction of "next year" model vehicles, and also eliminating an estimated .017 fraction of present year model vehicles. The age distributions for the remaining years were then adjusted (i.e., increased) to reflect this change.

The calculation for determining the heavy duty vehicle population in the Basin is shown below.

$$46{,}300 \left(1 + .104 \times \frac{6.5}{7}\right) .4918 = 252{,}000$$

The calculation for determinating the motorcycle population in the Basin is shown below, using a DMV prediction for statewide motorcycle population and the same vehicle population fraction used in the previous two calculations.

$$771{,}800 \times .4918 = 380{,}000$$

2-stroke motorcycles constitute 38% of the population, and 4-stroke make up the remainder.

TABLE B-1

June 30, 1977

LIGHT DUTY GASOLINE VEHICLE HIGH REACTIVE HYDROCARBON EXHAUST EMISSION INVENTORY

Model year	*Average Age (yr.)	**Vehicle Age Distribution	Total Basin Vehicle Population	Miles Driven Per Vehicle Year	Low Mileage Emission Factor (gm/mi)	Age Deterioration Factor	Conversion Factor (ton-yr.) (gm.-day)	Reactivity Factor	Emissions (ton) (day)
1977	1/2	.076	6.07×10^6	5,800	.23	1.23	3.02×10^{-9}	8	1.8
1976	1 1/2	.110	"	11,500	.23	1.7	"	"	7.3
1975	2 1/2	.101	"	10,200	.23	1.23****	"	"	4.3
1974	3 1/2	.0883	"	9,000	2.7	1.14	"	"	39.5
1973	4 1/2	.0936	"	7,700	2.7	1.16	"	"	33.5
1972	5 1/2	.0988	"	7,000	2.7	1.18	"	"	32.3
1971	6 1/2	.0873	"	6,000	2.9	1.21	"	"	26.9
1970	7 1/2	.0753	"	5,000	3.6	1.28	"	"	24.5
1969	8 1/2	.0622	"	4,400	4.4	1.30	"	"	22.9
1968	9 1/2	.0426	"	3,900	4.5	1.35	"	"	14.7
1967	10 1/2	.0382	"	3,800	4.6	1.21	"	"	11.8
1966	11 1/2	.0312***	"	3,300	6.0	1.35	"	"	12.2
1965 and earlier	12 1/2	.095	"	3,300	8.8	1.0	"	"	40.5
								Total	272.2

* These data were adjusted to reflect the fact that the inventory is for June 30, and not Dec. 31

** These data were adjusted to reflect the fact that the inventory is for June 30, and not Dec. 31 [i.e. the 2.3% of 1978 and an estimated 1.7% of 1977 vehicles that would have been purchased (see Table A-1) by year end are eliminated, and the age distributions adjusted (i.e. divided by .96) to account for this]

*** An estimation made to allow for the application of a 1966 emission factor.

**** This deterioration factor was changed (i.e., lowered) to reflect the fact that catalysts in 1975 can be changed after 25,000 miles, or approximate 2 years service.

TABLE B-2

June 30, 1977

Light Duty Gasoline Vehicle High Reactive Hydrocarbon
Crankcase and Evaporative Emission Inventory

Model Year	Age Distribution	Total Basin Vehicle Population	Miles Driven Per Vehicle Year	Emission Factor (gm/mi)	Conversion Factor (ton/yr.) (gm/day)	Reactivity Factor	Emissions (tons/day)
1977	.076	6.07×10^6	5,800	.2	3.02×10^{-9}	.67	1.08
1976	.110	"	11,500	.2	"	"	3.39
1975	.101	"	10,200	.2	"	"	2.52
1974	.0883	"	9,000	.2	"	"	2.15
1973	.0936	"	7,700	.2	"	"	1.77
1972	.0988	"	7,000	.2	"	"	1.70
1971	.0873	"	6,000	.5	"	"	3.21
1970	.0753	"	5,000	.5	"	"	2.31
1969	.0622	"	4,400	3.0	"	"	10.10
1968	.0426	"	3,900	3.0	"	"	6.12
1967	.0382	"	3,800	3.0	"	"	5.35
1966	.0312	"	3,300	3.0	"	"	3.79
1965 and earlier	.095	"	3,300	3.4*	"	"	13.10
						Total	56.59

* An estimate to reflect the 1965 and earlier average emission factor.

TABLE B-3

June 30, 1977

HEAVY DUTY GASOLINE VEHICLE HIGH REACTIVE HYDROCARBON EXHAUST EMISSION INVENTORY

Model Year	Average Age (yr.)	Vehicle Age Distribution	Total Basin Vehicle Population	Miles Driven Per Vehicle Year	Low Mileage Emission Factor (gm./mi)	Age Deterioration Factor	Conversion Factor (ton-yr.)/(gm.-day)	Reactivity Factor	Emissions (ton)/(day)
1977	1/2	.76	2.52×10^5	5,000	2.4	1.06	3.02×10^{-9}	.8	.59
1976	1 1/2	.110	"	10,000	2.4	1.15	"	"	1.60
1975	2 1/2	.101	"	"	"	1.20	"	"	1.77
1974	3 1/2	.0883	"	"	7.8	1.32	"	"	5.55
1973	4 1/2	.0936	"	"	"	1.25	"	"	5.56
1972	5 1/2	.0988	"	"	9.9	1.27	"	"	7.55
1971	6 1/2	.0873	"	"	15.0	1.29	"	"	10.30
1970	7 1/2	.0753	"	"	15.0	1.31	"	"	9.05
1969	8 1/2	.0622	"	"	19.0	1.0	"	"	7.22
1968 & earlier	9 1/2+	.2070	"	"	19.0	1.0	"	"	24.00
								Total	73.2

TABLE B-4

June 30, 1977

Heavy Duty Gasoline Vehicle High Reactive Hydrocarbon
Crankcase and Evaporative Emission Inventory

Model year	Age Distribution	Total Basin Vehicle Population	Miles Driven Per Vehicle Year	Emission Factor (gm/mi)	Conversion Factor (ton/yr.) (gm/day)	Reactivity Factor	Emissions (tons/day
1977	.76	2.52×10^5	5,000	.8	3.02×10^{-9}	.67	.16
1976	.110	"	10,000	.8	"	"	.45
1975	.101	"	"	.8	"	"	.41
1974	.0883	"	"	.8	"	"	.36
1973	.936	"	"	.8	"	"	.38
1972	.988	"	"	3.0	"	"	1.52
1971	.0873	"	"	3.0	"	"	1.34
1970	.0753	"	"	3.0	"	"	1.16
1969	.0622	"	"	3.0	"	"	.96
1968	.0426	"	"	3.0	"	"	.66
1967	.0382	"	"	3.0*	"	"	.58
1966	.0312	"	"	3.0*	"	"	.48
1965 and earlier	.095	"	"	3.4*	"	"	1.66
						Total	10.10

* These heavy duty vehicle hydrocarbon emission factors of Ref. (1), Table 16, were changed in order to reflect the fact that PCV devices were installed on heavy duty gasoline vehicles on the same schedule as the light duty vehicles.

TABLE B-5

June 30, 1977

2 Stroke Motorcycle High Reactive Hydrocarbon
Exhaust Emission Inventory

Vehicle Population	Miles Driven Per Vehicle Year	Emission Factor (gm/mi)	Conversion Factor (ton-yr)/(gm-day)	Reactivity Factor	Emissions Ton/Day
144,000	3,900	15.0	3.02×10^{-9}	.8	20.4

TABLE B-6

June 30, 1977

4 Stroke Motorcycle High Reactive Hydrocarbon
Exhaust Emission Inventory

Vehicle Population	Miles Driven Per Vehicle Year	Emission Factor (gm/mi)	Conversion Factor (ton-yr)/(gm-day)	Reactivity Factor	Emissions Ton/Day
236,000	3,900	3.3	3.02×10^{-9}	.8	7.36

TABLE B-7

June 30, 1977

4 Stroke Motorcycle High Reactive Hydrocarbon
Crankcase Emission Inventory

Vehicle Population	Miles Driven Per Vehicle Year	Emission Factor (gm/mi)	Conversion Factor (ton-yr)/(gm-day)	Reactivity Factor	Emissions Ton/Day
236,000	3,900	.7	3.02×10^{-9}	.67	1.3

TABLE B-8

June 30, 1977

2 Stroke Motorcycle Reactive Hydrocarbon
Evaporative Emission Inventory

Vehicle Population	Miles Driven Per Vehicle Year	Emission Factor (gm/mi)	Conversion Factor (ton-yr) (gm-day)	Reactivity Factor	Emissions Ton Day
144,000	3,900	.32	3.02×10^{-9}	.67	.36

TABLE B-9

June 30, 1977

4 Stroke Motorcycle Reactive Hydrocarbon
Evaporative Emission Inventory

Vehicle Population	Miles Driven Per Vehicle Year	Emission Factor (gm/mi)	Conversion Factor (ton-yr) (gm-day)	Reactivity Factor	Emissions Ton Day
236,000	3,900	.35	3.02×10^{-9}	.67	.65

APPENDIX C

June 30, 1977, Emissions Reductions
From Various Control Strategies
In the South Coast Air Basin
For on-Highway Gasoline Vehicle
High Reactive Hydrocarbons

I. Strategy Basis and Background:

The 1970 and 1977 high reactive hydrocarbon emissions from light and heavy duty vehicles and from 2 and 4 stroke motorcycles when considering emissions control based only on control devices installed on new vehicles, are shown in Table C-1. This table is a compilation of Appendix A and B calculation results.

Using the emissions shown in the 1977 column as a base, various control strategies are applied, and the emissions reductions obtained by these control strategies are shown in the various subsections of section II. It should again be pointed out and emphasized that the emissions reductions in tons/day that are calculated for each strategy, are the reductions that can be expected by the addition of a particular strategy only after the strategy or strategies previously evaluated have been implemented. In other words, the emission reductions are determined from an emission base that has been reduced by the strategies previously evaluated. As a result of this then, the reduction in tons/day of one strategy cannot be compared to the reduction obtained by another strategy because the emission base is altered (ie., lowered) after each strategy is applied.

The total emissions remaining and the emissions remaining for each model year after implementing each strategy on the two types of vehicles (light and heavy duty) and on the two sources of emission from these vehicles (exhaust and crankcase and evaporative emissions), are shown in Tables C-2, C-3, C-4 and C-5 at the end of the following section.

TABLE C-1

High Reactive Hydrocarbon Emissions From Light and Heavy Duty Vehicles and Motorcycles (A Compilation of Appendix A and B Results

Reactive Hydrocarbon Exhaust Emissions	Tons/Day 1970	Tons/Day 1977
a. Light duty vehicles (considering only factory installed control devices)	634.1	272.0
b. Heavy duty vehicles (considering only factory installed control devices)	101.0	73.2
c. 2-Stroke Motorcycle (no controls)	15.2	20.4
d. 4-Stroke Motorcycle (no controls)	5.5	7.4
Reactive Hydrocarbon Crankcase and Evaporative Emissions		
a. Light duty vehicles (considering only factory installed control devices)	247.6	56.6
b. Heavy duty vehicles (considering only factory installed control devices)	18.0	10.1
c. 2 and 4 Stroke motorcycle (no controls)	1.8	2.3
Total	1023.2	442.0

II. Strategy Calculations

1. State of California Vacuum Spark Advance Disconnect (VSAD), and PCV Valve Retrofit Program:

   a. VSAD retrofit on light and heavy duty vehicles for model years 1955-65:

   Hydrocarbon (HC) Reductions = (HC emissions subject to reduction) x (reduction factor)

   Reduction factor = .25 (based on the HC reduction shown for a VSAD and lean idle air fuel ratio adjustment in draft proposed EPA regulations (4))

   HC emissions subject to reduction = (1955-65 uncontrolled exhaust emissions) x (fraction of vehicles subject to retrofit based on make) x (change of ownership factor)

   1955-65 uncontrolled exhaust emission:

   $$(40.5 + 24 \times \frac{.095}{.207} = 40.5 + 11.0 = 51.5$$

   Fraction of vehicles subject to retrofit based on make:
   1 - *(foreign cars statewide in 1970 ÷ statewide total passenger cars) = 1 - (1,649,000/11,250,00) = 1 - .147 = .853

   Change of ownership factor (assuming 25% change of ownership per year[5]):

1972	1973	1974	1975	1976
.25 +	(.75x.25) +	(.56x.25)+	(.42x.25)+	(.31x.25)+

   1977
   (.23x.125) = .25 + .19 + .14 + .11 + .08 +.03 = .80

   HC reductions = 51.5 x .853 x .8 x .25 = 8.7

*Ref. ARB phone conversation; foreign cars = 1,649,000

b. VSAD retrofit on light duty vehicles for model years 1966-70:

HC reductions = (HC emissions subject to reduction) x (reduction factor)

reduction factor = .12 (based on the reductions shown for exhaust gas recalculations and VSAD[4])*

HC emissions subject to reduction = (1966-70 uncontrolled exhaust emissions) x (fraction of vehicles subject to retrofit)

1966-70 uncontrolled exhaust emissions = (12.2 + 11.8 + 14.7 + 22.9 + 24.5) = 86.1

fraction of vehicles subject to retrofit based on make = .853 (see Section II, 1.a)

HC reduction = 86.1 x .853 x .12 = 8.7

c. PCV retrofit on light and heavy duty vehicles for model years 1955-62.

HC reductions = (crankcase emissions subject to reduction) x (reduction factor)

reduction factor = 1.0 (complete control is assumed)

$$\text{HC reduction} = 13.10^{**} \times \frac{(.02)}{(.095)}^{***} \times \frac{((7.1 + 3.8)\quad .5-3)}{((7.1 + 3.8)\quad .5\ )}^{****}$$

$$+ 1.6^{**} \times \frac{(.02)}{(.095)}^{***} \frac{((8.2 + 3.8\quad .5-3)}{((8.2 + 3.8\quad .5\ )}^{****}$$

$$= 13.1 \times \frac{.02}{.095} \times .42 + 1.6 \times \frac{.02}{.095} \times .5$$

$$+ 1.2 + .2 = \underline{1.4}$$

*The emissions reduction factor of .12 is based on the EPA reference (4), which limits the application of this factor to pre-controlled (i.e. pre-1966) vehicles. However a conversation with an ARB staff member has revealed that ARB tests showed that one of the two VSAD devices approved for 1966-70 vehicles shows HC reductions of 22.2%, which indicates that the .12 reduction factor is a reasonable approximation.

**Crankcase and evaporative losses summed over a range of years.

***Estimated fraction of 1965 + earlier emissions that are applicable to 1955-62 vehicles

****Estimated fraction of emissions that are due to crankcase based on a corrected Table 16 of Ref. (1), see attachment.

2. Inspection and Maintenance Program, Claiming a 12% Exhaust Emissions Reduction (based on a loaded emission test per Ref. (4)):*

HC reductions = (light and heavy duty vehicle exhaust emissions available for reduction) x (reduction factor)

reduction factor = .12

light and heavy duty exhaust emissions available for reduction = (1.8 + 7.3 + 4.3 + 39.5 + 33.5 + 32.3 + 26.9 + 22.0 + 20.6 + 13.2 + 10.6 + 11.0 + 33.7) + (.59 + 1.60 + 1.77 + 5.55 + 5.56 + 7.5 + 10.30 + 9.05 + 7.22 + 22.10) = 256.7 + 71.3 = 328.0

HC reduction = 328 x .12 = 39.4

3. Evaporative control retrofit on light duty vehicles:

a. Evaporative control retrofit on light duty vehicles for model years 1966-69.

HC reduction = (HC emissions available for reduction) x (reduction factor)

Reduction factor: Using the corrected emission factors of Table 16, Ref. 1; assuming that the efficiency of retrofit devices will be equal to that of the 1970-71 new car devices; and assuming that the PCV control in 1966-69 is virtually complete, while evaporative cases are uncontrolled, the control factor is then -

$$\text{control factor} = \frac{3.0 - .5}{3} = \frac{2.5}{3} = .83$$

HC available for control = the HC evaporative and crankcase emission for the years 1966-69** = (3.79 + 5.35 + 6.12 + 10.0) = 25.6

HC reductions = 25.6 x .83 = 21

*Ref. 4 does not recommend a reduction factor for inspection and maintenance of heavy duty vehicles; therefore the use of .12 reduction factor is an estimate for these vehicles.

**For this range of years, crankcase control is considered to be total, therefore the emissions are entirely evaporative.

b. Evaporative control retrofit on heavy duty vehicles of model years 1966-72

HC reductions = (HC emissions available for reduction) x (reduction factor)

reduction factor: using the corrected emission factors of Table 16, Ref. 1; assuming that the efficiency of the retrofit devices will be equal to the new 1973 heavy duty vehicle devices; and assuming that the PCV control in 1966-69 is virtually complete, while evaporative losses are uncontrolled, the reduction factor is then -

$$\text{reduction factor} = \frac{3.0 - .8}{3.0} = .73$$

HC available for reduction = the HC evaporative and crankcase emissions for the years 1966-72* = (.48 + .58 + .66 + .96 + 1.16 + 1.34 + 1.52) = 6.7

HC reductions = 6.7 x .73 = 4.9

4. Gaseous Fuel Conversion for all Fleet Vehicles (i.e. $\geq$10 vehicles per owner) for Model Years 1971-74:

HC reductions = (emissions from gasoline vehicles replaced by gaseous fueled vehicles) - (emission from gaseous fueled vehicles)

Emissions from gaseous fueled vehicles in both private and public fleets:

*For this range of years, crankcase control is considered to be total, therefore the emissions are entirely evaporative.

PRIVATE FLEET DATA 1971*

Model Year	1971 Statewide Private Fleet	1977 So. Coast Basin Growth and Vehicle Popula-tive Proportional Factors	1977 So. Coast Basin Private Fleet
1977	169,000	1.082 x .4918	90,000
1976	132,000	1.082 x .4918	70,500
1975	118,000	1.082 x .4918	63,000
1974	102,000	1.082 x .4918	54,500
1973	62,000	1.082 x .4918	33,000
1972	43,000	1.082 x .4918	22,900
1971	41,000	1.082 x .4918	21,800
1970 & earlier	162,000	1.082 x .4918	86,500
			442,300

Model Year	1970 Statewide Public Fleet	1977 So. Coast Basin Growth and Propor-tional Factors	1977 Model Year Proportional Factors (See Previous Table	1977 So. Coast Basin Public Fleet
1974	194,000	1,097 x .4918	54,500 / 442,300	12,900
1973	194,000	1,097 x .4918	33,100 / 442,300	7,900
1972	194,000	1,097 x .4918	22,900 / 442,300	5,500
1971	194,000	1.097 x .4918	21,600 / 442,300	5,000

Model Year	Private and Public Light and Heavy Duty Fleet Vehicles
1974	54,000 + 12,900 = 67,400
1973	33,000 + 7,900 = 40,900
1972	22,900 + 5,500 = 28,400
1971	21,800 + 5,000 = 26,800

* Based on DMV data supplied by ARB

Using vehicle population data from Appendix B, the ratio of the Basin heavy duty vehicle population to total vehicle population is as follows:

$$\frac{2.52 \times 10^5}{6.07 \times 10^6 + 2.52 \times 10^5} = .0398$$

Because of this small proportion of heavy duty vehicles to the total population, it was assumed for ease of calculation that the vehicles converted would all be light duty.

The emissions from the gaseous fueled fleet vehicles are then calculated as follows:

Model Yr.	Total Basin Fleet Vehicles.	Adjusted Emission Factor (gm/mi) *	Miles Driven Per Vehicle Yr.	Conversion Factor (Ton/Yr) (gm/day)	Reactivity ***	Emissions (Ton)
1974	67,400	.7	12,400**	3.02×10^{-9}	.85	1.50
1973	40,900	.7	"	"	"	.91
1972	28,400	.7	"	"	"	.63
1971	26,800	1.0	"	"	"	.85

* The state 7-mode emission factor was multiplied by 2 to approximate an equivalent CVS-2 emission factor

* A value vased on ARB interviews with fleet operators

***This factor was estimated by the ARB on the basis of several research reports

Emissions from gasoline fueled vehicles replaced by gaseous fueled vehicles:
The following table shows the calculations involved in estimating the number of light duty vehicles that are replaced by the gaseous fueled fleet vehicles. The concept used to evaluate this is that the total VMT produced by the gaseous fueled vehicles is equal to the total VMT of the gasoline vehicles replaced.

Model Yr.	Total Gaseous VMT = Total Gasoline VMT	Equivalent Gasoline Vehicles Replaced
1974	67,400 x 12,400 = χ x 9,000	χ = 93,000
1973	40,900 x 12,400 = χ x 7,700	χ = 66,000
1972	28,400 x 12,400 = χ x 7,000	χ = 50,300
1971	26,800 x 12,400 = χ x 6,000	χ = 55,400

The gasoline exhaust and the gasoline crankcase and evaporative emissions eliminated by the gaseous fueled fleet conversion are calculated by multiplying the total gasoline HC emissions for the model years affected by the ratio of the vehicles replaced over the number of vehicles for each model year. These calculations are as follows:

Gasoline High Reactive HC Eliminated

Model Yr.	Gasoline Exhaust Emissions Eliminated	(Ton) (day)	Gasoline Vapor Emissions Eliminated	(Ton) (day)
1974	$34.8 \times \frac{9.3 \times 10^4}{6.07\times 10^6} \times .0883$	= 6.1	$2.15 \times \frac{9.3 \times 10^4}{6.07 \times 10^6} \times .0883$	= .37
1973	$29.5 \times \frac{6.6 \times 10^4}{6.07\times 10^6} \times .0936$	= 3.4	$1.77 \times \frac{6.6 \times 10^4}{6.07\times 10^6} \times .0936$	= .21
1972	$28.4 \times \frac{5.03 \times 10^4}{6.07 \times 10^6} \times .0988$	= 2.4	$1.70 \times \frac{5.03 \times 10^4}{6.07 \times 10^6} \times .0988$	= .20
1971	$23.7 \times \frac{5.54 \times 10^4}{6.07 \times 10^6} \times .0873$	= 2.5	$3.21 \times \frac{5.54 \times 10^4}{6.07 \times 10^6} \times .0873$	= .34
		14.4		1.12

HC reductions = (emissions from gasoline fueled vehicles replaced by gaseous fueled vehicles) - (emissions from gaseous fueled vehicles)

= (14.4 + 1.12) - 3.89

= 15.52 - 3.89

= 11.63

5. Oxidizing Catalyst Retrofit Program on Light and Heavy Duty Vehicles* for Model years 1966-1974:
   HC reduction = (HC emissions available for reduction) x (reduction factor)
   reduction factor = .5 (Ref. (4)
   HC emissions available for reduction = (exhaust emissions remaining after previous controls are implemented) x (conversion factor)**

*Although the reduction factor in Ref. (4) is limited to light duty vehicles, it is felt that this factor could reasonably be applied to heavy duty vehicle retrofit also. New York is now in the process of testing catalyst retrofit or heavy duty vehicles per EPA, Don Armstrong (Land-Use Planning Branch) and the proposed New York Air Plan.

**This is a factor derived on the basis of discussion with Dr. Joel Horowitz of EPA, and Mr. Jack Gockel of Clean Air Research Co. The number indicates the fraction of vehicles that could be catalyst retrofited, based on the availability of unleaded high octane fuel for high compression engines.

exhaust emissions remaining after previous controls are implemented = (30.2 + 27.0 + 26.6 + 22.1 + 19.4 + 18.1 + 11.6 + 9.3 + 9.7) + (4.88 + 4.89 + 6.64 + 9.06 + 7.96 + 6.35 + 19.4 x $\frac{.112)}{.207)}$ = 174 + 50.3 = 224.3

HC reductions = 224.3 x .75 x .5 = 84.3

6. Reduction of Vehicle Miles Traveled (VMT) and Gasoline Marketing Emissions by Means of Gasoline Rationing: Gasoline rationing unlike the other mobile control strategies, does have an affect on non-vehicular emissions. The non-vehicular sources affected in this case are the gasoline marketing or transfer operations. It is assumed that the emissions from gasoline marketing operations are reduced in direct proportion to the reduction in gasoline sales as a result of gas rationing. A further simplifying assumption is made that a given percentage of gas rationing will result in a equal percentage reduction in VMT.

   Based on the California Air Implementation Plan, the gasoline marketing operations without additional control, would result in 75 tons/day of high reactive hydrocarbons in 1977. The state plan shows a reduction of 65 tons/day of high reactive hydrocarbons using vapor recovery systems during gasoline transfer operations, indicating a control efficiency of 87%. Estimating that approximately 82% gas rationing will be needed to meet the air quality standards in 1977, the gasoline marketing emission inventory is then adjusted to reflect this as follows:

   Gasoline marketing emissions reductions = Reductions from 82% gas rationing

   + Reductions from vapor controlled gasoline marketing operations after 82% gas rationing

   = 75x.82+75x.78x.87

   = 62+12

The emissions reductions that are estimated from the applications of additional stationary source control, are discussed in Appendix D. The stationary emissions remaining are 64 tons/day.

The amount of emissions that can be affected by gasoline rationing is then determined. It is conservatively assumed that motorcycle VMT will not be reduced by gas rationing; therefore the emissions available for reduction by gas rationing are the light and heavy duty exhaust and evaporative-crankcase vehicle emissions. They are as follows:

(150.12 + 33.2 + 43.86 + 5.03) = 232

The emissions that will not be reduced by gas rationing are the remaining stationary sources, motorcycle emissions, and aircraft emissions. These emissions are as follows: (64 + 30 + 24) = 118

The allowable emissions are calculated to be 161 tons/day based on the 1970 high oxidant reading of .62 ppm associated with an emissions inventory of 1251 tons/day of high reactive hydrocarbons. This leaves only 161 - 118 = 43 tons/day that can be emitted from the remaining sources.

This means that only 43 of the 232 tons/day of light and heavy duty vehicle emissions can be allowed. The remaining amount of emissions or VMT reduction is accomplished by gasoline rationing, and the percent of gasoline rationing required is then:

$\frac{(232 - 43)}{232}$ 100% = 81.5% gas rationing (i.e. VMT reduction)

This is very close to the estimated 82% gas rationing used in the gasoline marketing emissions calculation and therefore no recalculation is necessary.

The total reductions from gas rationing are the sum of the emissions reductions that this control strategy produces on the gasoline marketing and VMT emission sources. These reductions are as follows:

62 + (232-43) = 62 + 189 = 251

TABLE C-2

June 30, 1977

Strategy Running Inventory
Light Duty Gasoline Vehicle High Reactive Hydrocarbon
Exhaust Emissions

Emissions $\left(\frac{\text{Tons}}{\text{Day}}\right)$

Model Year	Appendix B Emissions With New Car Controls Only	VSAD & PCV Retrofit	Inspection & Maintenance	Evaporative Control Retrofit	Gaseous Fuel Conversion Retrofit	Oxidizing Catalyst Retrofit	81.5% Gas Rationing
1977	1.8	1.8	→ 1.6	1.6	1.6	1.60	→ .28
1976	7.3	7.3	→ 6.4	6.4	6.4	6.40	→ 1.13
1975	4.3	4.3	→ 3.8	3.8	3.8	3.80	→ .67
1974	39.5	39.5	→ 34.8	34.8	→ 30.2	→ 18.90	→ 3.30
1973	33.5	33.5	→ 29.5	29.5	→ 27.0	→ 16.90	→ 3.00
1972	32.3	32.3	→ 28.4	28.4	→ 26.6	→ 16.60	→ 2.92
1971	26.9	26.9	→ 23.7	23.7	→ 22.1	→ 13.70	→ 2.41
1970	24.5	→ 22.0	→ 19.4	19.4	19.4	→ 12.10	→ 2.13
1969	22.9	→ 20.6	→ 18.1	18.1	18.1	→ 11.30	→ 1.97
1968	14.7	→ 13.2	→ 11.6	11.6	11.6	→ 7.25	→ 1.28
1967	11.8	→ 10.6	→ 9.3	9.3	9.3	→ 5.81	→ 1.02
1966	12.2	→ 11.0	→ 9.7	9.7	9.7	→ 6.06	→ 1.07
1965 & earlier	40.5	→ 33.7	→ 29.7	29.7	29.7	29.70	→ 5.13
Total	272.2	256.7	226.0	226.0	215.5	150.12	26.31

NOTE: An arrow indicates that the emissions at the tail of the arrow are reduced to the amount at the head of the arrow by the strategy listed above the arrowhead column.

TABLE C-3

June 30, 1977

Strategy Running Inventory
Heavy Duty Gasoline Vehicle High Reactive Hydrocarbon
Exhaust Emissions

Emissions $\left(\frac{\text{Tons}}{\text{Day}}\right)$

Model Year	Appendix B Emissions With New Car Controls Only	VSAD & PCV Retrofit	Inspection & Maintenance Retrofit	Evaporative Control	Gaseous Fuel Conversion Retrofit	Oxidizing Catalyst Retrofit	81.5% Gas Rationing
1977	.59	.59	→ .52	.52	.52	.52	→ .09
1976	1.60	1.60	→ 1.41	1.41	1.41	1.41	→ .25
1975	1.77	1.77	→ 1.56	1.56	1.56	1.56	→ .27
1974	5.55	5.55	→ 4.88	4.88	4.88	→ 3.05	→ .54
1973	5.56	5.56	→ 4.89	4.89	4.89	→ 3.06	→ .54
1972	7.55	7.55	→ 6.64	6.64	6.64	→ 4.15	→ .73
1971	10.39	10.30	→ 9.06	9.06	9.06	→ 5.66	→ 1.00
1970	9.05	9.05	→ 7.96	7.96	7.96	→ 4.98	→ .88
1969	7.22	7.22	→ 6.35	6.35	6.35	→ 3.97	→ .70
1968 & earlier	24.00	→ 22.10	→ 19.40	19.40	19.40	→ 15.50	→ 2.73
Total	73.19	71.29	62.67	62.67	62.67	43.86	7.73

NOTE: An arrow indicates that the emissions at the tail of the arrow are reduced to the amount at the head of the arrow by the strategy listed above the arrowhead column.

TABLE C-4

June 30, 1977

Strategy Running Inventory
Light Duty Gasoline Vehicle High Reactive Hydrocarbon
Crankcase and Evaporative Emissions

Emissions $\left(\frac{\text{Tons}}{\text{Day}}\right)$

Model Year	Appendix B Emissions with New Car Controls Only	VSAD & PCV Retrofit	Inspection & Maintenance	Evaporative Control Retrofit	Gaseous Fuel Conversion Retrofit	Oxidizing Catalyst Retrofit	81.5% Gas Rationing
1977	1.08	1.08	1.08	1.08	1.08	1.08 →	.19
1976	3.39	3.39	3.39	3.39	3.39	3.39 →	.60
1975	2.52	2.52	2.52	2.52	2.52	2.52 →	.44
1974	2.15	2.15	2.15	2.15 →	1.78	1.78 →	.31
1973	1.77	1.77	1.77	1.77 →	1.56	1.56 →	.27
1972	1.70	1.70	1.70	1.70 →	1.50	1.50 →	.26
1971	3.21	3.21	3.21	3.21 →	2.87	2.87 →	.51
1970	2.31	2.31	2.31	2.31	2.31	2.31 →	.41
1969	10.10	10.10	10.10 →	1.70	1.70	1.70 →	.30
1968	6.12	6.12	6.12 →	1.04	1.04	1.04 →	.18
1967	5.35	5.35	5.35 →	.91	.91	.91 →	.16
1966	3.78	3.78	3.79 →	.64	.64	.64 →	.11
1965 & earlier	13.10 →	11.90	11.90	11.90	11.90	11.90 →	2.10
Total	56.59	55.39	55.39	34.32	33.20	33.20	5.84

NOTE: An arrow indicates that the emissions at the tail of the arrow are reduced to the amount at the head of the arrow by the strategy listed above the arrowhead column.

TABLE C-5

June 30, 1977

Strategy Running Inventory
Heavy Duty Gasoline Vehicle High Reactive Hydrocarbon
Crankcase and Evaporative Emissions
Emissions $(\frac{Tons}{Day})$

Model Year	Appendix B Emissions With New Car Controls Only	VSAD & PCV Retrofit	Inspection & Maintenance	Evaporative Control Retrofit	Gaseous Fuel Conversion Retrofit	Oxidizing Catalyst Retrofit	81.5% Rationing
1977	.16	.16	.16	.16	.16	.16 →	.03
1976	.45	.45	.45	.45	.45	.45 →	.08
1975	.41	.41	.41	.41	.41	.41 →	.07
1974	.36	.36	.36	.36	.36	.36 →	.06
1973	.38	.38	.38	.38	.38	.38 →	.07
1972	1.52	1.52	1.52 →	.41	.41	.41 →	.07
1971	1.34	1.34	1.34 →	.36	.36	.36 →	.06
1970	1.16	1.16	1.16 →	.31	.31	.31 →	.05
1969	.96	.96	.96 →	.26	.26	.26 →	.05
1968	.66	.66	.66 →	.18	.18	.18 →	.03
1967	.58	.58	.58 →	.16	.16	.16 →	.03
1966	.48	.48	.48 →	.13	.13	.13 →	.02
1965 & earlier	1.66 →	1.46	1.46	1.46	1.46	1.46 →	.26
TOTAL	10.11	9.92	9.92	5.03	5.03	5.03	.88

NOTE: An arrow indicates that the emissions at the tail of the arrow are reduced to the amount at the head of the arrow by the strategy listed above the arrowhead column.

APPENDIX D

1977 Emission Reductions
From Various Control Strategies
In the South Coast Air Basin
For Stationary Source High Reactive Hydrocarbons

I 1977 Stationary Source Emissions (not including gasoline marketing):

1977 emissions and growth projections were taken from the State Implementation Plan. The 1977 emissions are projected to be 140 tons/day if no additional controls are placed on stationary sources from 1970 to 1977.

II 1977 Stationary Source Reductions:

1. Dry Cleaning Vapor Control:

The State Plan indicated that there would be 6 tons/day of high reactive hydrocarbon emissions from dry cleaning operations in 1977. The Cal Tech EQL report (2) indicated that virtually complete control of these emissions could be accomplished by activated carbon scrubbing. Based on this, complete control was assumed, resulting in a reduction of 6 tons/day.

2. Trichloroethylene (TCE) Degreaser, Substitution:

The State Plan predicted that there would be 25 tons/day of high reactive emissions from degreasing operations. The Cal Tech EQL report (2) indicated that these emissions consisted of TCE high reactive solvent, which could be easily replaced by a non-reactive substitute, 1,1,1-Trichloroethane. With this control strategy implemented, an additional 25 tons/day of high reactive emissions are eliminated.

3. Additional Stationary Control Rule Strengthening:

Emissions from surface coatings and miscellaneous solvent usage are estimated in the State Plan to be 91 tons/day. The Cal Tech EQL report (2), and conversations with the Los Angeles APCD, indicated that a 50% reduction in high reactive hydrocarbons would be accomplished by rule strengthening (primarily Rule 66). Making this assumption, an additional reduction of 45 tons/day is taken.

The uncontrolled 1977 stationary emissions and the reductions from the strategies discussed in the previous subsections are shown in the table below.

	Tons/day
1977 Uncontrolled stationary high reactive HC emissions	+140
Control Strategies	
a. Dry cleaning vapor control	- 6
b. Degreaser substitution	- 25
c. Rule 66 Strengthening (50%)	- 45
Emissions remaining after implementation of control measures	+ 64

APPENDIX E

Normalizing the Emissions Reductions Of Interacting Control Strategies

The problem of evaluating various control strategies by comparing the calculated emission reductions, has been pointed out in the report body and Appendix C. This appendix presents an approach that can be used to realistically evaluate the emissions reductions that can be related to each control strategy.

In order to determine which control strategies are interacting on the various emission sources, a list of the emission sources and the control strategies that affect each source are listed as follows:

a. Light duty gasoline exhaust emissions

   1. VSAD & PCV retrofit program
   2. Inspection and maintenance
   3. Gaseous fuel conversion
   4. Oxidizing catalyst retrofit
   5. Gasoline rationing

b. Heavy duty gasoline exhaust emissions

   1. VSAD & PCV retrofit program
   2. Inspection and maintenance
   3. Oxidizing catalyst retrofit
   4. Gasoline rationing

c. Light duty evaporative and crankcase emissions

   1. VSAD & PCV retrofit program
   2. Vehicle evaporative retrofit
   3. Gaseous fuel conversion
   4. Gasoline rationing

d. Heavy duty evaporative and crankcase emissions

   1. VSAD & PCV retrofit program
   2. Vehicle evaporative retrofit
   3. Gasoline rationing

e. Gasoline marketing

   1. Gasoline marketing operation vapor controls
   2. Gasoline rationing

f. Dry cleaning emissions

   1. Activated charcoal scrubbing

g. Degreasing solvent emissions

1. Substitute non-reactive substitute

h. Solvent coating and miscellaneous sources

1. Rule 66 Tightening (50%)

i. Aircraft emissions

1. Federal emission regulations

In order to do the most realistic normalizing, the emission sources should be broken into their smallest possible components as is done above.

The purpose of normalizing again, is to fairly or realistically proportion the total reductions. This normalizing problem presents itself when more than one strategy is applied to a single type or category of emissions, as is the case with emission sources listed a. thru e..

After the listing, the next step is to calculate an "emissions weighting factor" for each strategy that is applied to an emissions source. Using the emissions source listed -- "a. light duty gasoline exhaust emissions" as an example, the weighting or normalizing process is then demonstrated. The first step in determining the "emissions weighting factor" in this example is to calculate the reductions in tons/day that each of the 5 control strategies could produce when applied to the uncontrolled emissions value that is calculated in Appendix B and is found in Table B-1 under total emissions. These calculated reductions are the emissions reductions that each strategy would produce if none of the other 4 strategies were implemented. Each of these emission values is then divided by the total emissions available for reduction* (i.e. Table B-1 total emissions).

*The division of each of these emission values by the total emission is actually not necessary, but is done here because it appears to be an intuitive help to visualize this approach. The problem could be solved by calling the emission values the "emission weighting factors," and proceeding through the problem as outlined. All that is needed is a set of numbers that show the relative affect of each strategy to any of the other strategies. The numbers produced by the first multiplication step have this property.

The fraction resulting from each of these divisions or ratios, is the "emission weighting factor" for each of the 5 strategies as applied to this particular emissions source. The utility of these emission weighting factors does not depend on their absolute value, but depends instead on the relative values of the factors to each other. The next step is to add these "emission weighting factors" and divide this sum into the actual emissions reductions that are provided by this combination of strategies on this particular emission source. The actual emission reduction for this case is found from Table C-2 by subtacting the total of the last column from the first column. The normalized emission reduction for each strategy as applied to this emission source is then calculated by multiplying the result of the last division exercise by the "emission weighting factor" for each strategy.

The type of exercise just described is applied to each of the emission sources a. thru e., and the weighted emissions of the individual strategies as applied to the various emission sources are summed to give the total weighted emission reduction that should be credited to each control strategy.

Calculations:

a. Light duty vehicle gasoline exhaust emissions:

Emission weighting factors:

1. VSAD & PCV retrofit program

$$\frac{272.2 - 256.7}{272.2} = \frac{15.2}{272.2} = .0558$$

2. Inspection and maintenance

$$\frac{.12 \times 272.2}{272.2} = .12$$

3. Gaseous fuel conversion

Recalculating the emissions of the vehicles replaced by gaseous fuel (see Appendix C, Section II, 4):

$$6.1 \times \frac{39.5}{34.8} = 6.92$$

$$3.4 \times \frac{33.5}{29.5} = 3.86$$

$$2.4 \times \frac{32.3}{29.5} = 2.73$$

$$2.5 \times \frac{26.9}{23.7} = \underline{2.84}$$

$$16.35$$

Reduction = 16.35 -3.89 = 12.46

$$\frac{12.46}{272.2} = .04$$

4. Oxidizing catalyst retrofit

(39.5 +33.5 +32.3 +26.9 +24.5 +22.9 +14.7 +11.8 +12.2).75 x .5 = 218.3 x .75 x .5 = 81.8

$$\frac{81.8}{272.2} = .301$$

5. Gasoline rationing

$$\frac{272.2 \times .824}{272.2} = .824$$

Summation of emission weighting factors:

$$\begin{array}{r} .0558 \\ .1200 \\ .0400 \\ .3010 \\ .8240 \\ \hline 1.3408 \end{array}$$

Actual emissions reduction divided by summation of weighting factors:

$$\frac{272.2 - 26.31}{1.3408} = \frac{245.89}{1.3408} = 183.2$$

Normalized emission reductions:

VSAD & PCV retrofit = 183.2 x .0558 = 10.22
Inspection and maintenance = 183.2 x .12 = 22.00
Gaseous fuel conversion = 183.2 x .04 = 7.33
Oxidizing catalyst retrofit = 183.2 x .301 = 55.10
Gas rationing = 183.2 x .824 = 151.00

b. Heavy duty vehicle gasoline exhaust emissions:

Emission weighting facors:

1. VSAD & PCV retrofit

$$\frac{73.19 - 71.29}{73.19} = \frac{1.9}{73.19} = .0259$$

2. Inspection and maintenance

$$\frac{73.19 \times .12}{73.19} = .12$$

3. Oxidizing catalyst retrofit

(5.55 +5.56 +7.55 +10.39 +9.05 +7.22 +24.00 $\frac{x\ .112}{.207}$
.75 x .5 = 58.34 x .75 x .5 = 21.9

$$\frac{21.9}{73.19} = .300$$

4. Gasoline rationing

$$\frac{73.19 \times .624}{73.19} = .824$$

Summation of emission weighting factors:

```
 .0259
 .1200
 .3000
 .8240
1.2699
```

Actual emissions divided by summation of weighting factors:

$$\frac{73.19 - 7.73}{1.2699} = \frac{65.46}{1.2699} = 51.6$$

Normalized emission reductions:

VSAD & PCV retrofit = 51.6 x .0259 = 1.34
Inspection and maintenance = 51.6 x .12 = 6.19
Oxidizing catalyst retrofit = 51.6 x .30 = 15.50
Gasoline rationing = 51.6 x .824 = 42.50

c. Light duty vehicle gasoline evaporative and crankcase emissions:

Emission weighting factors:

1. VSAD & PCV retrofit program

$$\frac{56.59 - 55.39}{56.59} = \frac{1.2}{56.59} = .0212$$

2. Vehicle evaporative retrofit

$$\frac{55.39 - 34.32}{56.59} = \frac{21.07}{56.59} = .373$$

3. Gaseous fuel conversion

$$\frac{34.34 - 33.20}{56.59} = \frac{1.12}{56.59} = .0198$$

4. Gasoline rationing

$$\frac{56.59 \times .824}{56.59} = .824$$

Summation of emission weighting factors:

$$\begin{array}{r} .0212 \\ .3730 \\ .0198 \\ \underline{.8240} \\ 1.2380 \end{array}$$

Actual emissions reduction divided by summation of emission weighting factors:

$$\frac{56.59 - 5.84}{1.2380} = \frac{50.75}{1.2380} = 41.0$$

Normalized emission reductions:

VSAD & PCV retrofit = 41.0 x .0212 = .87
Vehicle evaporative retrofit = 41.0 x .373 = 15.30
Gaseous fuel conversion = 41.0 x .0198 = .81
Gasoline rationing = 41.0 x .824 = 33.80

d. Heavy duty vehicle evaporative and crankcase emissions:

Emission weighting factors:

1. VSAD & PCV retrofit

$$\frac{10.11 - 9.92}{10.11} = \frac{.19}{10.11} = .0188$$

2. Vehicle evaporative retrofit

$$\frac{9.92 - 5.03}{10.11} = \frac{4.89}{1.011} = .4830$$

3. Gasoline rationing

$$\frac{10.11 \times .824}{10.11} = .824$$

Summation of emission weighting factors:

$$\begin{array}{r} .8240 \\ .4830 \\ \underline{.0188} \\ 1.3258 \end{array}$$

Actual emissions reduction divided by summation of weighting factors:

$$\frac{10.11 - .88}{1.3258} = \frac{9.23}{1.3258} = 6.96$$

Normalized emission reductions:

VSAD & PCV retrofit = 6.96 x .0188 = .13
Vehicle evaporative retrofit = 6.96 x .483 = 3.37
Gasoline rationing = 6.96 x .824 = 5.74

e. Gasoline marketing

Emission Weighting factors:

1. Marketing vapor control

$$\frac{65}{75} = .866$$

2. Gasoline rationing

$$\frac{61.8}{75} = .825$$

Summation of emission weighting factors:

$$\begin{array}{r} .866 \\ \underline{.825} \\ 1.691 \end{array}$$

Actual emissions reduction divided by summation of emission weighting factors:

$$\frac{62+12}{1.691} = \frac{74}{1.691} = 43.1$$

Normalized emission reductions:

Marketing vapor control = 43.1 x .866 = 37.4
Gasoline rationing = 43.1 x .825 = 35.6

f. Dry cleaning emissions

Normalized reduction = 6

g. Degreasing solvent emissions

Normalized reduction = 25

h. Rule 66 strengthening

Normalized reduction = 45

i. Aircraft emissions

Normalized reduction = 11

Total Normalized Reductions:

<u>Total VSAD & PCV normalized reductions</u>

10.22
1.34
.87
.13
12.56 tons/day

<u>Total inspection and maintenance normalized reductions</u>

22.00
6.19
28.19 tons/day

<u>Total gaseous fuel conversion normalized reductions</u>

7.33
.81
8.14 tons/day

Total oxidizing catalyst retrofit normalized reductions

55.10
15.50
70.60 tons/day

Total gas rationing normalized reductions

151.00
42.50
33.80
5.74
35.60
268.64 tons/day

Total vehicle evaporative retrofit normalized reductions

15.30
3.37
18.67 tons/day

Gasoline marketing vapor control normalized reductions

37.4 tons/day

Dry cleaning normalized reductions

6 tons/day

Degreasing solvent normalized reductions

25 tons/day

Rule 66 strengthening normalized reductions

45 tons/day

Aircraft normalized reductions

11 tons/day

References:

(1) D. S. Kircher, D. P. Armstrong, EPA, draft report "An Interim Report on Motor Vehicle Emission Estimation," October 1972

(2) L. Lees, M. Braly, J. Trijonis, et al, California Institute of Technology - Environmental Quality Laboratory, "SMOG - A Report to the People," 1972

(3) P. Pekkala, Automobile Manufacuturers Association Inc., "1971 Motor Truck Facts"

(4) EPA internal draft of proposed regulations "Revisions to Requirements for Preparation, Adoption and Submittal of Implementation Plan," November 14, 1972

(5) G. Hass, R. Alexander, A. S. Cooper, C. Harper, R. Moliso, "Task Force Report on Periodic Vehicle Inspection and Maintenance for Emissions Control and Recommended Program for California," October, 1972

(6) Chass, R., Lunche R., et al, Los Angeles Co. Air Pollution Control District "Profile of Air Pollution Control" as of January 1971

(7) EPA contracted study conducted by TRW under Basic Ordering Agreement Number 68-02-0048 and titled "Transportation Control Strategies for State Air Quality Implementation Plans"

ATTACHMENT

Light Duty and Heavy Duty Vehicle

Crankcase and Evaporative Hydrocarbon

Emissions by Model Year

California ONLY

Model Year	LDV Hydrocarbons GM/MI	HDV Hydrocarbons GM/MI	
Pre 1961	7.1	8.2	
1961 - 1963	3.8	3.8	PCV Voluntary
1964 - 1967	3.0	3.0	
1968 - 1969	3.0	3.0	
1970 - 1971	0.5	3.0	Improved PCV for 100% control &
1972	0.2	3.0	
	Evap. Control		
1973 on	0.2	0.8 Evap. Control	

This table is an adjustment of Table 16 from Ref (1).

Metropolitan Los Angeles Intrastate Air Quality Control Region Transportation Control Plan Standards vs. VMT Reductions

Summary:

This report predicts the effect of varying degrees of vehicle miles traveled reduction (VMTR) in the Los Angeles Air Quality Control Region (AQCR) on air quality in 1977.

Days/Year 0.08 is exceeded	Standard (STD) or Maximum 1-hour Oxidant reading (ppm) (1 day/yr.)	VMTR* %
6	0.10	64
10	0.108	57
20	0.122	45
30	0.133	35
40	0.140	29
50	0.147	23
102	0.174	0

*Assumes all other controls carried out (e.g., retrofit, vapor recovery, etc.).

Calculations to determine # of days various oxidant standards will be exceeded with various degrees of VMT reductions (e.g. gas rationing)

1. Maximum 1-hour oxidant reading, 1970: 0.62 ppm.

2. Total emissions projected for 1977 without VMTR:

   350 tons/day (assuming 3.a. - 3.e. and stationary source controls are implemented)

3. Light and heavy duty gasoline vehicle emissions in 1977 after the following controls are implemented = 232 tons/day

   a. State PCV & VSAD Plan
   b. EPA Inspection/Maintenance
   c. EPA Evaporative Retrofit
   d. EPA Gaseous Fueling
   e. EPA Oxidizing Catalyst

4. VMT strategy can be applied to item 3 only, other sources are assumed uneffected by VMT reductions.

5. Allowable emissions if STD = 0.08 is to be attained:

   $$\frac{0.08}{0.62} \text{ X } 1251 \text{ tons/day} = 161 \text{ tons/day}$$

   where 1251 tons/day = 1970 total emissions

   $$\text{VMTR} = 1 - \frac{(161-118)}{232} 100 = 81.5\%$$

   where 118 = emissions unaffected by VMTR = (350 - 232)

6. Allowable emissions if STD. = 0.1:

   $$\frac{0.10}{0.62} \text{ X } 1251 \text{ tons/day} = 202 \text{ tons/day}$$

   $$\text{VMTR} = 1 - \left(\frac{202 - 118}{232}\right) 100 = 63.8\%$$

7. Allowable emissions if STD. = 0.147:

   $$\frac{0.147}{0.62} \text{ X } 1251 \text{ tons/day} = 296 \text{ tons/day}$$

   $$\text{VMTR} = 1 - \left(\frac{296 - 118}{232}\right) 100 = 23.3\%$$

8. Determine tons/day allowable if STD = 0.08 is exceeded 5, 10, 15, ... days/year:

6 days = $\frac{6}{365}$ = 1.64% of year

10 days	2.74%
15	4.1
20	5.5
25	6.8
30	8.2
35	
40	10.1
45	
50	13.7

Using graph 1, attached:

Days/Year .08 is exceeded (N)	Oxidant Maximum 1-hr. reading (ppm) (M)	Hydrocarbon Ton/Day Allowable[1] (A)	VMTR[2] %
6	0.100	202	64
10	0.108	218	57
15	0.118	238	48
20	0.122	246	45
25	0.128	258	40
30	0.133	269	35
40	0.140	283	29
50	0.147	297	23
102	0.174	350	0

(1) This column is calculated as follows:

$$\frac{M}{0.62} \times 1251 = A \text{ (tons/day)}$$

where: M = Oxidant Maximum 1-hr. reading
.62 = Oxidant maximum 1-hr. reading in 1970
1251 = 1970 reactive hydrocarbon emissions
A = Reactive hydrocarbon emissions allowable

(2) This column is calculated as follows:

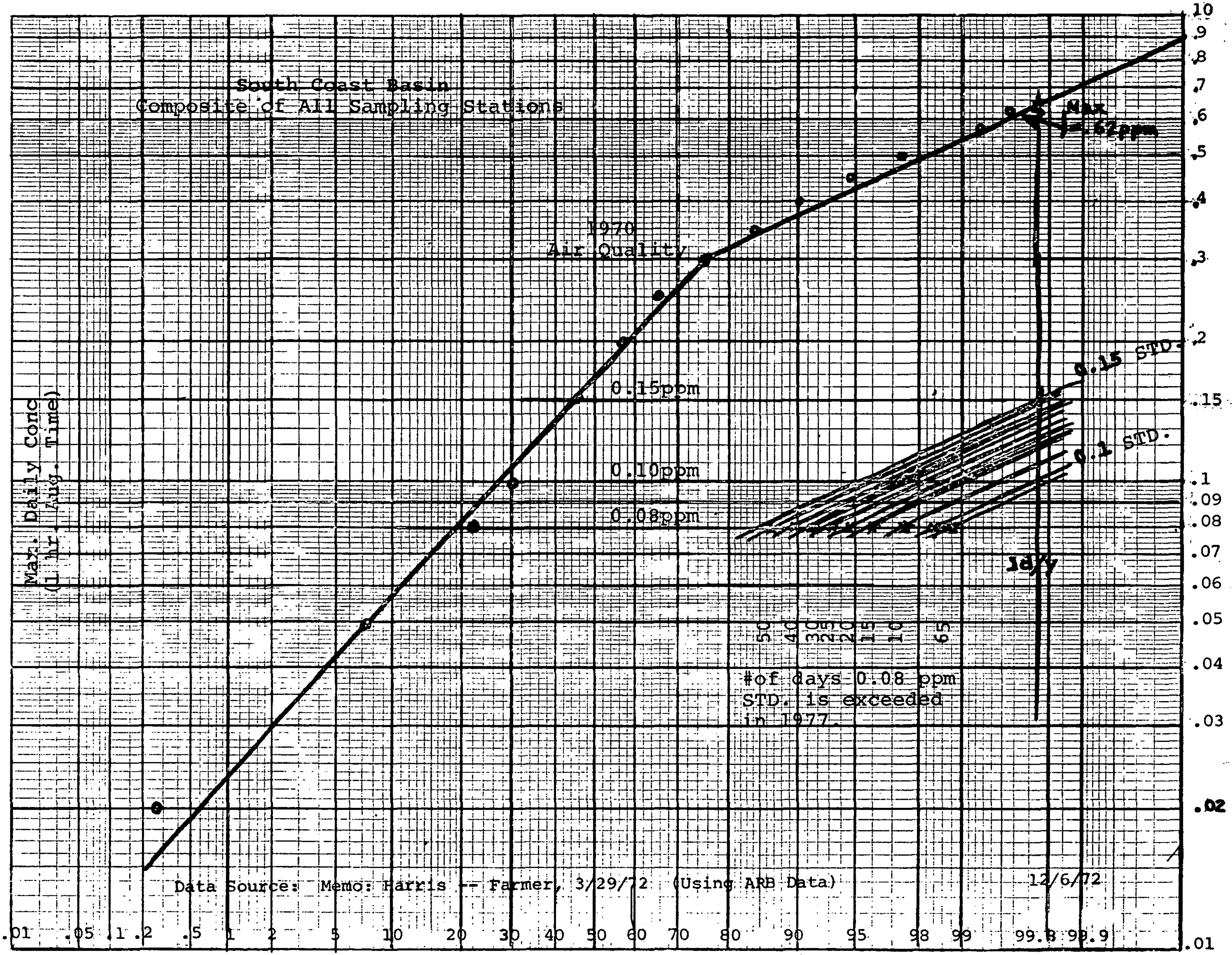
$$VMTR = 1 - \frac{(A - 118)}{232} \; 100$$

where: 118 = emissions unaffected by VMTR
232 = emission affected by VMTR (1977)

1970 - South Coast Basin
Composite of all stations

Month	Number of days exceeding the specified concentration of oxidant													
	.6	.5	.4	.35	.30	.25	.20	.15	.10	.08	.05	.02	.01	Maximum # of days extra control necessary
January	0	0	0	0	0	0	0	1	5	10	23	30	31	0
February	0	0	0	0	0	0	1	5	12	14	22	28	-	0
March	0	0	0	0	0	1	4	7	17	21	28	31	-	0
April	0	0	0	0	0	3	5	11	17	22	29	30	-	0
May	0	0	1	2	5	7	9	23	29	30	31	-	-	2
June	0	1	7	11	16	21	24	29	30	-	-	-	-	7
July	0	1	9	15	22	28	31	-	-	-	-	-	-	10
August	1	4	10	15	23	28	31	-	-	-	-	-	-	10
September	1	4	8	14	17	23	28	30	-	-	-	-	-	8
October	0	0	1	2	6	14	20	21	29	31	-	-	-	3
November	0	0	0	0	0	1	3	9	18	21	27	31	-	0
December	0	0	0	0	0	0	0	3	10	17	26	31	-	0
Annual	2	10	36	59	89	126	156	201	259	288	339	364	365	0

Note: This data is used to develop the plot on the following page


South Coast Basin
Composite of All Sampling Stations
1970
Air Quality
Max
=.62ppm
0.15ppm
0.10ppm
0.08ppm
0.15 STD.
0.1 STD.
1d/y
50 40 30 20 15 10 6 5
#of days 0.08 ppm
STD. is exceeded
in 1977.
Max. Daily Conc
(1 hr. Avg. Time)
Data Source: Memo: Harris -- Farmer, 3/29/72 (Using ARB Data)
12/6/72
.01 .05 .1 .2 .5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.8 99.9
10 .9 .8 .7 .6 .5 .4 .3 .2 .15 .1 .09 .08 .07 .06 .05 .04 .03 .02 .01

Future Emissions in Metropolitan Los Angeles Air Quality Control Region (i.e. South Coast Air Basin)

SUMMARY

The attached graph shows the emissions of reactive hydrocarbons (RHC) for the years 1970 through 1990. All retrofit controls were assumed installed in applicable model-years, but no vehicle miles traveled (VMT) reduction strategy was used. As can be seen from the graph, the allowable high reactive hydrocarbon emissions of 161 tons/day will always be exceeded. Minimum VMT reduction will be required in 1985 to meet the 161 tons/day (T/D) limit (for .08 ppm oxidant standard). The VMT reductions for light and heavy duty gasoline vehicles would be 59%, assuming a 1.7% average growth.

If zero growth is assumed after 1977, total emissions will still be 211 T/D in 1985, and the light and heavy duty gasoline vehicle VMT reduction needed to meet the oxidant standard would be 43%.

Assumptions, Calculations and Data

Assumptions:

1. All light and heavy duty gasoline vehicles in 1985 will be 1975 and later model years (i.e., meet 1975 low mileage emission standards when new).

2. Average vehicle age in 1985 and later years = 5 years.

3. Catalyst replacement @ 25,000 miles or approximately 2 years of service.

4. Deterioration factor for average light duty vehicle population age of 5 years = 2.4 and for heavy duty vehicle population of 5 years = 1.26 (Ref. EPA - Armstrong, Kircher, draft emission factors).

5. Light duty 1975 gasoline vehicle low mileage emission factors are:

   .2 gm/mile - crankcase and evaporation hydrocarbons
   .23 gm/mile - exhaust hydrocarbons

   Heavy duty 1975 gasoline vehicle low mileage emission factors are:

   .8 gm/mile - crankcase and evaporation hydrocarbons
   2.4 gm/mile - exhaust hydrocarbons

   Motorcycle emissions in 1970 and 1977 are per EPA "Control Strategy Package Report."

   Reactivity factor for exhaust emissions is .8 and for crankcase and evaporative emissions is .67.

6. Average light duty vehicle VMT per car year = 8,200
   Average heavy duty vehicle VMT per truck year = 10,500
   Average motorcycle VMT per vehicle year = 3,900

7. Gasoline marketing operation emitted 68 T/D of RHC in 1970 and an estimated 10 T/D in 1977 with vapor recovery controls.

8. 1977 light duty vehicle population = 6.07×10^6

9. 1977 heavy duty vehicle population = 2.52×10^5

10. Aircraft produced 33 T/D of RHC in 1970 and an estimated 24 T/D of RHC in 1977 with additional controls. In 1985, these emissions are estimated to be 10 T/D assuming more stringent controls and no growth from 1977.

11. Motorcycle emissions in 1985 are considered to be controlled, and are estimated to be 10 T/D assuming no growth from 1977.

Calculations:

1. Stationary, aircraft, and gasoline marketing emissions for year Y = 1977 no growth emissions [1 + .017 x (Y-1977)]

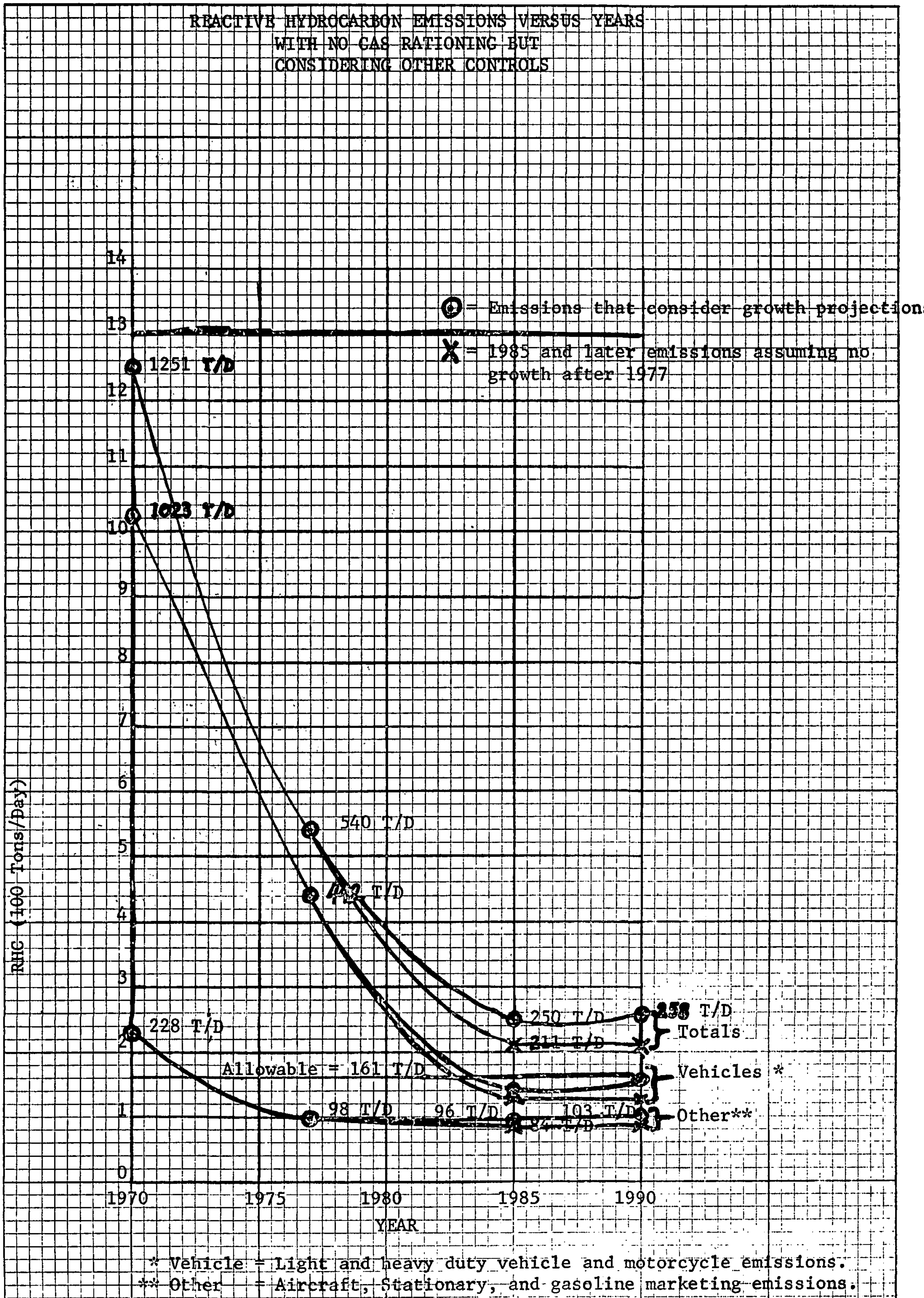
   where: .017 = average yearly growth factor
   Y = calendar year after 1977

2. Vehicle emissions for year Y = low mileage emission factor x deterioration factor x basin vehicle population x miles traveled per vehicle year x conversion factor for gm/years→tons/day x [1 + .017 x (Y-1977)]

Data:

Vehicle (i.e., light and heavy duty gasoline vehicles and motorcycles) emissions in 1970 = 1023 T/D and in 1977 = 262 T/D (with no gas rationing but with all retrofit controls). This data is from recent EPA Region IX calculations (see EPA Control Strategy Package Report).

Stationary source emissions (not including gasoline marketing emissions) in 1970 = 127 T/D, and in 1977 after additional controls = 64 T/D. These figures are from the State Implementation Plan and the EPA Control Strategy Package Report.


REACTIVE HYDROCARBON EMISSIONS VERSUS YEARS
WITH NO GAS RATIONING BUT
CONSIDERING OTHER CONTROLS
= Emissions that consider growth projections
= 1985 and later emissions assuming no growth after 1977
1251 T/D
1023 T/D
540 T/D
T/D
250 T/D
T/D
211 T/D
228 T/D
Totals
Allowable = 161 T/D
Vehicles *
98 T/D
96 T/D
103 T/D
84 T/D
Other**
RHC (100 Tons/Day)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
1970
1975
1980
1985
1990
YEAR
* Vehicle = Light and heavy duty vehicle and motorcycle emissions.
** Other = Aircraft, Stationary, and gasoline marketing emissions.