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Comparison of Ambient NMHC/ NO_x Ratios with NMHC/NO_x Ratios Calculated from Emission Inventories

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Comparison of Ambient NMHC/NO_x Ratios with NMHC/NO_x Ratios Calculated from Emission Inventories

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1.0 INTRODUCTION AND SUMMARY

One method for revising State Implementation Plans to meet the ambient oxidant standards is the Empirical Kinetic Modeling Approach (EKMA). This method requires the determination of the ratio of non-methane hydrocarbons (NMHC) to oxides of nitrogen (NO_x). It is recommended in the EKMA method (Environmental Protection Agency 1977, EPA-450/2-77-021a) that the ratio of NMHC/NO_x be calculated with ambient air monitoring data. However, due to the lack of adequate air monitoring data in some locations, local agencies have proposed using emission inventory data to calculate the appropriate NMHC/NO_x ratio. The purpose of this project was to determine what differences result from calculating NMHC/NO_x ratios from emission inventory data compared with the EKMA recommended technique of calculating NMHC/NO_x ratios from ambient monitoring data, and to rationally explain the differences between the two methods.

Three geographic locations were considered in analyzing the differences between NMHC/NO_x ratios calculated from emission inventory data and those from ambient monitoring data. The three locations were chosen due to the availability of detailed gridded emission inventories and the large number of air monitoring sites in each location. The following three locations were used:

1. Los Angeles, California
2. San Francisco, California
3. St. Louis, Missouri

Ambient monitoring data from five high oxidant days in each of the three locations were used to calculate 6-9 a.m. NMHC/NO_x ratios, as specified in the EKMA method.

The emission inventory data involved detailed hourly gridded emission data in Los Angeles and San Francisco in addition to county-wide emission data in each of the three locations. Because the EKMA

method requires volumetric NMHC/NO_x ratios in units of ppmC/ppm, it was necessary to adjust the emission NMHC/NO_x ratios from units of mass to units of volume. Since NO_x emission rates are normally expressed as NO_2 (molecular weight = 46) and hydrocarbon emission rates are normally expressed as CH_4 (molecular weight = 16), all emission NMHC/NO_x ratios were multiplied by 46/16 or 2.875 to convert to the volumetric units of ppmC/ppm.

The relationship between ambient monitoring NMHC/NO_x ratios and emission inventory NMHC/NO_x ratios was tested by applying a linear regression analysis to air quality and emission data from a number of monitoring stations in each region. The relationship was tested for each of five high-oxidant days in each of the three locations - Los Angeles, San Francisco, and St. Louis. The basic result found in all three locations was that there was little correlation between NMHC/NO_x ratios calculated from ambient monitoring data and the corresponding NMHC/NO_x ratios calculated from emission inventory data. There was some improvement in correlation when gridded emission ratios were used instead of countywide emission ratios in the San Francisco area, but the correlations in general were not significant.

Since the EKMA method normally requires ambient monitoring data from the main downtown urban center in a region, a brief analysis was made comparing the numerical values of averaged ambient NMHC/NO_x ratios with emission NMHC/NO_x ratios in the central downtown areas of the three locations. Perhaps fortuitously, the countywide emission NMHC/NO_x ratio compared reasonably well with the averaged ambient NMHC/NO_x ratio in each of the three downtown locations. This relationship should be further studied for a larger number of cities to determine its usefulness.

Due to a lack of correlation between the two methods of ratio calculation, it was difficult to assess a definite reason for the discrepancy between the two methods. Probably the most important reason for the differences between ambient NMHC/NO_x ratios and emission ratios is the influence of meteorology on ambient pollutant concentrations. Emissions and ambient pollutants from different regions can be transported to the location of an air monitoring station. Another major reason for the discrepancy between the two methods of ratio calculation is probably the lack of detail and inaccuracy in most emission inventories, since day-to-day variations in emissions are normally not represented and some important sources may be omitted from inventories.

Because of the lack of correlation between NMHC/NO_x ratios calculated from ambient air monitoring data and NMHC/NO_x ratios calculated from emission inventory data, it is recommended that only ambient monitoring data be used in the EKMA technique to calculate the ratio of nonmethane hydrocarbons to oxides of nitrogen.

2.0 LOS ANGELES DATA ANALYSIS

2.1 AMBIENT AIR MONITORING DATA

Ambient monitoring data for Los Angeles, California for non-methane hydrocarbons (NMHC) and oxides of nitrogen (NO_X) were derived from the records of the Southern California Air Pollution Control District, Metropolitan Zone. A search was made of data from the year 1975 to determine the 5 days with the highest hourly oxidant readings in the region, as recommended in the Empirical Kinetic Modeling Approach (EKMA). When these five high oxidant days were determined, hourly data for NMHC and NO_X for the hours of 6-9 a.m. (local daylight time) were examined at eight air monitoring stations in the region. All of the eight air monitoring stations were in one large county, Los Angeles County. For each station, the hourly values from 6-9 a.m. were averaged for NMHC and NO_X concentrations, and these average values were used to calculate the NMHC/NO_X ratio for each station. The ambient air monitoring data for each of the 5 days in Los Angeles are shown in the five tables in Appendix A.

An examination of the individual hourly concentration data showed that the NO_X data were fairly uniform and did not exhibit extreme fluctuations from day to day; however, the NMHC values varied widely from one day to the next. NMHC concentrations are not measured directly, but are derived by subtracting measured methane concentration values from measured total hydrocarbon concentration values; thus, NMHC values are normally less accurate than measured NO_X concentration values. Because of possible inaccuracies in low NMHC values, it was decided to exclude data from a station where any of the three hourly NMHC values was 0.3 ppmC or less. The remaining 3-hour averaged ambient NMHC/NO_X ratios are summarized in Table 2-1 for the eight stations in Los Angeles. Site descriptions of the Los Angeles monitoring stations are listed in Table 2-2. The 6-9 a.m. ambient air monitoring NMHC/NO_X ratios ranged from a low of 1.39 to a high of 13.30, in units of ppmC/ppm.

Table 2-1. LOS ANGELES NMHC/NO_x RATIO SUMMARY

Monitoring Station	6-9 a.m. Ambient Air Ratio					6-9 a.m. Gridded Emission Ratio*	Countywide Emission Ratio*
	7/11/75	8/2/75	8/6/75	9/21/75	10/3/75		
Central Los Angeles	4.09	4.11	-	4.28	3.43	3.71	3.51
East San Gabriel Valley	-	-	3.24	-	-	10.81	3.51
East San Fernando Valley	3.35	7.13	13.30	2.96	8.18	3.08	3.51
Northwest Coastal	1.39	-	1.31	5.53	3.63	6.04	3.51
West San Fernando Valley	2.63	1.96	1.92	2.38	3.13	6.27	3.51
Pomona-Walnut Valley	2.24	1.71	1.25	2.76	4.14	7.07	3.51
Southeast	9.81	7.00	6.85	6.88	6.30	7.39	3.51
West San Gabriel Valley	3.79	2.94	3.05	5.56	2.33	5.69	3.51

*Adjusted to represent ppmC/ppm

2.2 EMISSION INVENTORY DATA

A gridded emission inventory developed by Nordsieck (1974) was used to calculate the corresponding emission NMHC/NO_x ratios. The emission inventory was representative of a typical summer day in Los Angeles. Emissions were projected for the year 1975 from the base year of 1972. The emission inventory was based on a 2 mile x 2 mile square grid system, and emissions were adjusted to represent 6-9 a.m. (local daylight time) values by using appropriate diurnal patterns (CALTRANS 1975). The 6-9 a.m. emissions, due to the traffic rush hour, represented a higher fraction of mobile source emissions than the average daily emissions.

The position of each air monitoring station was located on the grid system, and a weighted emission average was calculated based on an inverse-square distance relationship among the four closest grid squares to the air monitoring station location. This technique was used so that the calculated emissions would represent 6-9 a.m. emissions in a 2 mile x 2 mile square centered on the air monitoring location. Thus, if an air monitoring station were located at the intersection point of four grid squares, emissions from the four grid squares would be averaged; conversely, if a monitoring station were located near the center of a grid square, the emissions from that square would be weighted most heavily. The calculated Los Angeles gridded emissions and the adjusted NMHC/NO_x ratios (in units of ppmC/ppm) are shown in Table 2-2. The calculated emission NMHC/NO_x ratios ranged from a low of 3.08 to a high of 10.81. These emission ratios are representative of a typical summer day in Los Angeles.

The Los Angeles NMHC/NO_x ratios from ambient monitoring data and the corresponding ratios from the gridded emission inventory are summarized in Table 2-1. Also shown in Table 2-1 is the average countywide NMHC/NO_x emission ratio (adjusted to represent ppmC/ppm), which is calculated from annual emission estimates for Los Angeles County (Kinosian 1977). However, since all eight ambient monitoring stations were in the same large county, only the gridded emission NMHC/NO_x ratios were used in the following statistical analysis.

Table 2-2. LOS ANGELES GRIDDED EMISSION INVENTORY DATA

Monitoring Station	Site Description	County	6-9 a.m. NMHC(kg/hr)	6-9 a.m. NO_x(kg/hr)	NMHC/NO_x*
Central Los Angeles	Center city, commercial	Los Angeles	172.0	133.1	3.71
East San Gabriel Valley	Center city, residential	Los Angeles	21.8	5.8	10.81
East San Fernando Valley	Center city, commercial	Los Angeles	23.7	22.2	3.08
Northwest Coastal	Center city, commercial	Los Angeles	99.6	47.4	6.04
West San Fernando Valley	Center city, residential	Los Angeles	176.7	81.1	6.27
Pomona-Walnut Valley	Center city, commercial	Los Angeles	66.8	27.2	7.07
Southeast	Center city, commercial	Los Angeles	211.8	82.3	7.39
West San Gabriel Valley	Center city, commercial-residential	Los Angeles	89.3	45.1	5.69

*Adjusted to represent ppmC/ppm

2.3 RATIO COMPARISON

A linear least-squares regression analysis (Bevington 1969) was carried out on the data in Table 2-1. Ambient NMHC/NO_x ratios for each day in Los Angeles were compared with the corresponding gridded emission NMHC/NO_x ratios. Only gridded emission data were analyzed since all eight monitoring stations were in the same county. The results are shown in Table 2-3.

There was no significant correlation for any of the 5 days in Los Angeles between NMHC/NO_x ratios calculated from ambient air monitoring data and NMHC/NO_x ratios calculated from the gridded emission inventory. The linear correlation coefficients ranged from -0.53 to 0.31, which are not significant for the number of data points analyzed. For seven data points to be significant at the 5 percent level, a correlation coefficient of 0.75 is necessary. The best fit linear regression lines through the data points are plotted for each day in Figure 2-1, with the emission ratio as the independent variable.

Although the correlations were not significant, it is interesting to examine the numerical values of the ratios for the downtown Los Angeles station, since this station might be used for an EKMA analysis over the entire Los Angeles area. For this station, the gridded emission NMHC/NO_x ratio was 3.71 and the countywide emission ratio was 3.51, as shown in Table 2-1. The averaged ambient monitoring NMHC/NO_x ratio for four high oxidant days at the Central Los Angeles station, as shown in Table 2-1, was 3.98, only 7 percent higher than the gridded emission ratio and 13 percent higher than the county-wide emission ratio.

Table 2-3. LOS ANGELES NMHC/NO_x RATIO COMPARISON USING GRIDDED EMISSION DATA

Date	Number of Data Points	Correlation Coefficient	Slope, a*	Intercept, b*
7/11/75	7	0.27	0.45	1.37
8/02/75	6	-0.35	-0.48	6.78
8/06/75	7	-0.53	-0.99	10.99
9/21/75	7	0.31	0.32	2.53
10/03/75	7	-0.30	-0.38	6.58

*Linear regression equation, $y=ax + b$, where:

x = emission data ratio
y = ambient air ratio

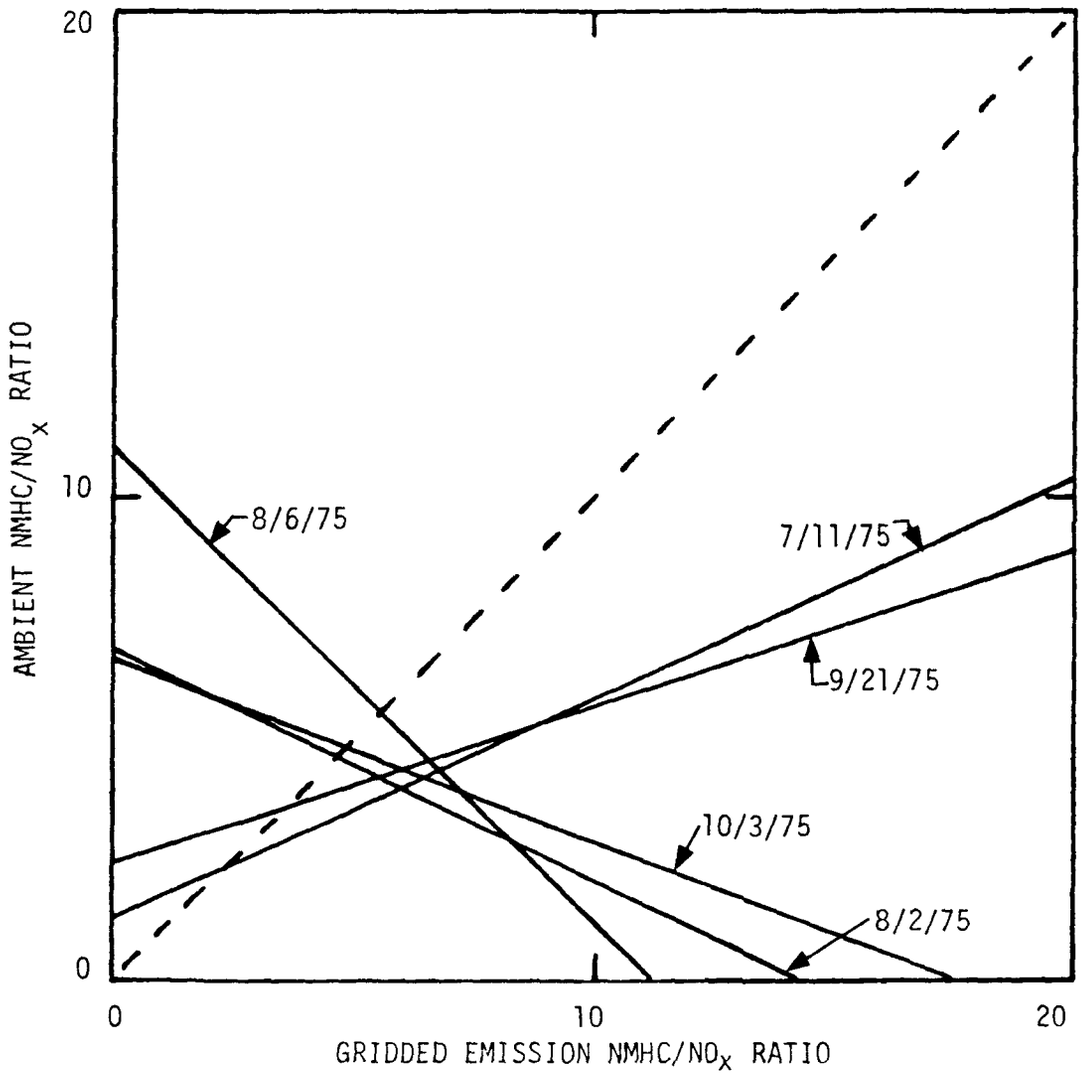

Figure 2-1. BEST-FIT REGRESSION LINES FOR FIVE HIGH-OXIDANT DAYS IN LOS ANGELES, COMPARING GRIDDED EMISSION NMHC/NO_x RATIOS WITH AMBIENT RATIOS. THE DASHED LINE REPRESENTS PERFECT THEORETICAL AGREEMENT.

3.0 SAN FRANCISCO DATA ANALYSIS

3.1 AMBIENT AIR MONITORING DATA

Ambient air data for San Francisco, California were obtained from the records of the San Francisco Bay Area Pollution Control District. Although both total hydrocarbon concentrations and methane concentrations are measured in the Bay Area, only total hydrocarbon concentration data are reduced and reported on a regular basis. Fortunately, the Association of Bay Area Governments (ABAG) had reduced NMHC data for a number of stations for one month, October 1976. Thus, the ambient monitoring data used in the analysis were based on the five highest oxidant days for October 1976. Total hydrocarbon concentrations in October were similar to those measured during the summer months of 1976. For the five highest oxidant days in October, 6-9 a.m. (local standard time) averaged concentrations were calculated for NMHC and NO_x. These values were used to calculate the ambient ratios of NMHC/NO_x. The ambient air monitoring data for each day in the San Francisco area are shown in the five tables in Appendix B.

An examination of the hourly concentration data revealed that the NO_x data were much more uniform than the NMHC data, as was found in Los Angeles. Again, it was decided to eliminate data from a station in which any hourly value of NMHC was 0.3 ppmC or less. Also, it was decided to eliminate a very anomalous NMHC/NO_x ratio of 38.57 found at the Gilroy station on October 7, 1976. The remaining 3-hour averaged ambient air NMHC/NO_x ratios are summarized in Table 3-1. Site descriptions of the San Francisco monitoring stations are listed in Table 3-2. The 6-9 a.m. ambient air monitoring NMHC/NO_x ratios for nine stations in the San Francisco area ranged from a low of 1.31 to a high of 7.65, in units of ppmC/ppm.

Table 3-1. SAN FRANCISCO NMHC/NO_x RATIO SUMMARY

Air Monitoring Station	6-9 a.m. Ambient Air Monitoring Ratio					6-9 a.m. Gridded Emission Ratio*	Countywide Emission Ratio*
	10/5/76	10/6/76	10/7/76	10/8/76	10/9/76		
Potrero	1.82	-	-	-	-	2.16	4.08
San Jose	3.72	4.41	3.33	2.26	5.10	9.86	4.23
Sunnyvale	-	2.78	4.75	-	2.85	9.26	4.23
Vallejo	2.33	4.70	4.21	-	-	8.14	3.85
Livermore	7.22	7.65	-	6.08	5.73	10.41	4.54
Pittsburg	4.00	-	3.53	-	-	1.12	2.79
San Rafael	-	1.31	1.88	1.24	1.50	5.49	4.77
Santa Rosa	2.00	2.27	-	-	-	7.56	4.43
San Francisco	4.38	4.93	-	2.11	-	11.64	4.08

*Adjusted to represent ppmC/ppm

3.2 EMISSION INVENTORY DATA

A gridded emission inventory for the San Francisco area for the year 1973 was provided by the Bay Area Air Pollution Control District (Robinson 1977). Emissions were distributed on a 2 kilometer x 2 kilometer square grid system, and were representative of a typical summer day in San Francisco. It should be noted that emissions for the month of October may be different than for a typical summer day. As was done in Los Angeles, the air monitoring stations were located on the grid system, and a weighted emission average was calculated using an inverse-square distance relationship among the four closest grid squares to the air monitoring location. Thus, the resulting emissions represented values for a 2 kilometer x 2 kilometer square centered on the air monitoring station. Since hourly gridded emissions were available, averaged emissions of NO_x and NMHC were calculated for 6-9 a.m. (local standard time). The resulting gridded emission data and the corresponding adjusted NMHC/NO_x ratios (in units of ppmC/ppm) are shown in Table 3-2. The gridded emission ratios ranged from a low of 1.12 to a high of 12.05.

Average countywide emission inventory data were obtained from the California Air Resources Board (Kinosian 1977). These emissions data represented hydrocarbon emissions in three different reactivity categories, as shown in Table 3-3. It was assumed in the analysis that Classes II and III represented NMHC emissions; since some compounds other than methane are included in Class I, this assumption may result in a somewhat lower estimate of NMHC emissions. The average countywide emissions for the San Francisco area and the resulting adjusted NMHC/NO_x ratios (in units of ppmC/ppm) are shown in Table 3-4. The countywide emission ratios ranged from a low of 2.79 to a high of 4.74. The gridded emission NMHC/NO_x ratios and the countywide emission ratios, with the ambient air monitoring ratios, are summarized in Table 3-1 for the San Francisco area.

Table 3-2. SAN FRANCISCO GRIDDED EMISSION INVENTORY DATA

Monitoring Station	Site Description	County	6-9 a.m. NMHC (kg/hr)	6-9 a.m. NO_x (kg/hr)	NMHC/NO_x*
Potrero	Center city, industrial	San Francisco	86.4	115.6	2.16
San Jose	Center city, residential	Santa Clara	135.7	39.6	9.86
Sunnyvale	Center city, commercial	Santa Clara	63.7	19.8	9.26
Vallejo	Center city, commercial	Solano	35.6	12.6	8.14
Livermore	Center city, commercial	Alameda	100.4	27.7	10.41
Richmond	Center city, commercial	Contra Costa	61.2	23.4	7.53
Pittsburg	Center city, commercial-industrial	Contra Costa	43.2	110.2	1.12
San Rafael	Center city, commercial-residential	Marin	55.1	28.8	5.49
Napa	Center city, commercial	Napa	69.1	16.5	12.05
Gilroy	Center city, commercial	Santa Clara	47.5	17.6	7.76
Santa Rosa	Center city, commercial	Sonoma	61.6	23.4	7.56
San Francisco	Center city, commercial-industrial	San Francisco	298.8	73.8	11.64

*Adjusted to represent ppmC/ppm

Table 3-3. CALIFORNIA AIR RESOURCES BOARD HYDROCARBON REACTIVITY CLASSES

Class I (Low Reactivity)	Class II (Moderate Reactivity)	Class III (High Reactivity)
C_1-C_2 paraffins	Mono-tert-alkyl-benzenes	All other aromatic hydrocarbons
Acetylene	Cyclic ketones	All olefinic hydrocarbons (including partially halogenated)
Benzene	Alkyl acetates	Aliphatic aldehydes
Benzaldehyde	2-Nitropropane	Branched alkyl ketones
Acetone	C_3+ paraffins	Cellosolve acetate
Methanol	Cycloparaffins	Unsaturated ketones
Tert-alkyl alcohols	N-alkyl ketones	Primary and secondary C_2 alcohols
Phenyl acetate	N-methyl pyrrolidone	Diacetone alcohol
Methyl benzoate	N,N-dimethyl acetamide	Ethers
Ethyl Amines	Alkyl phenols*	Cellosolves
Dimethyl formamide	Methyl phthalates**	Glycols*
Perhalogenated hydrocarbons		C_2+ alkyl phthalates**
Partially halogenated paraffins		Other esters**
Phthalic anhydride**		Alcohol amines**
Phthalic acids**		C_3+ organic acids + di acid**
Acetonitrile*		C_3+ di acid anhydrides**
Acetic acid		Formin** (Hexa methylene-tetramine)
Aromatic amines		Terpenic hydrocarbon
Hydroxyl amines		Olefin oxides**
Naphthalene*		
Chlorobenzenes*		
Nitrobenzenes*		
Phenol*		

* Reactivity data are either nonexistent or inconclusive, but conclusive data from similar compounds are available; therefore, rating is uncertain but reasonable.

** Reactivity data are uncertain.

Table 3-4. SAN FRANCISCO COUNTYWIDE EMISSION INVENTORY DATA

County	NMHC (metric tons/day)	NO_x (metric tons/day)	$NMHC/NO_x$*
Alameda	163.3	103.4	4.54
Contra Costa	149.7	154.2	2.79
Marin	29.7	17.9	4.77
Napa	14.2	9.3	4.40
San Francisco	80.4	56.4	4.08
San Mateo	93.4	56.8	4.74
Santa Clara	179.6	122.5	4.23
Solano**	31.8	23.7	3.85
Sonoma**	34.3	22.2	4.43

* Adjusted to represent ppmC/ppm

**Emissions for portion of county in San Francisco Bay Area Air Basin

3.3 RATIO COMPARISON

A linear least-squares regression analysis (Bevington 1969) was conducted on the San Francisco data, comparing the ambient air monitoring NMHC/NO_X ratios with the gridded emission ratios in Table 3-1. A linear regression analysis was also conducted comparing the ambient air monitoring ratios with the countywide emission ratios; the ambient air ratios were averaged if two or more air monitoring stations were in the same county. The results are shown in Table 3-5.

Again, the correlations between NMHC/NO_X ratios calculated from ambient air monitoring data and NMHC/NO_X ratios calculated from emission inventory data were mostly not significant. However, the gridded emission inventory ratios provided somewhat better correlation than the countywide emission inventory ratios. The gridded emission correlation coefficients ranged from 0.35 to 0.89. As shown in Table 3-5, the ambient air NMHC/NO_X ratios on October 6, 1976 and the gridded emission ratios had a 0.74 correlation coefficient, which for seven data points is significant at the 5-percent level. Likewise, the ambient air ratios on October 9, 1976 and the gridded emission ratios had a correlation coefficient of 0.89, which for four data points is significant at the 10-percent level. The other 3 days did not have significant correlations with the gridded emission ratios. The regression lines for the gridded emission ratios are plotted for each day in Figure 3-1.

The comparison of the ambient air monitoring NMHC/NO_X ratios with the countywide emission ratios produced less significant correlations than with the gridded emission ratios. The countywide emission correlation coefficients ranged from -0.51 to 0.16, which are not significant for the number of data points analyzed. Regression lines for the countywide emission ratios are plotted in Figure 3-2.

Table 3-5. SAN FRANCISCO NMHC/NO_x RATIO COMPARISON

1. Using Gridded Emission Data

Date	Number of Data Points	Correlation Coefficient	Slope, a*	Intercept, b*
10/05/76	7	0.44	0.20	2.18
10/06/76	7	0..4[1]	0.76	-2.80
10/07/76	5	0.35	0.11	2.82
10/08/76	4	0.44	0.36	-0.40
10/09/76	4	0.89[2]	0.78	-3.07

2. Using Countywide Emission Data

Date	Number of Data Points	Correlation Coefficient	Slope, a*	Intercept, b*
10/05/76	6	0.16	0.48	1.81
10/06/76	6	-0.30	-2.02	12.81
10/07/76	4	-0.49	-0.62	5.83
10/08/76	4	0.10	0.17	-0.02
10/09/76	3	-0.51	-4.01	21.82

*Linear regression equation, $y = ax + b$, where:
x = emission data ratio
y = ambient air ratio

[1]Significant at the 5% level

[2]Significant at the 10% level

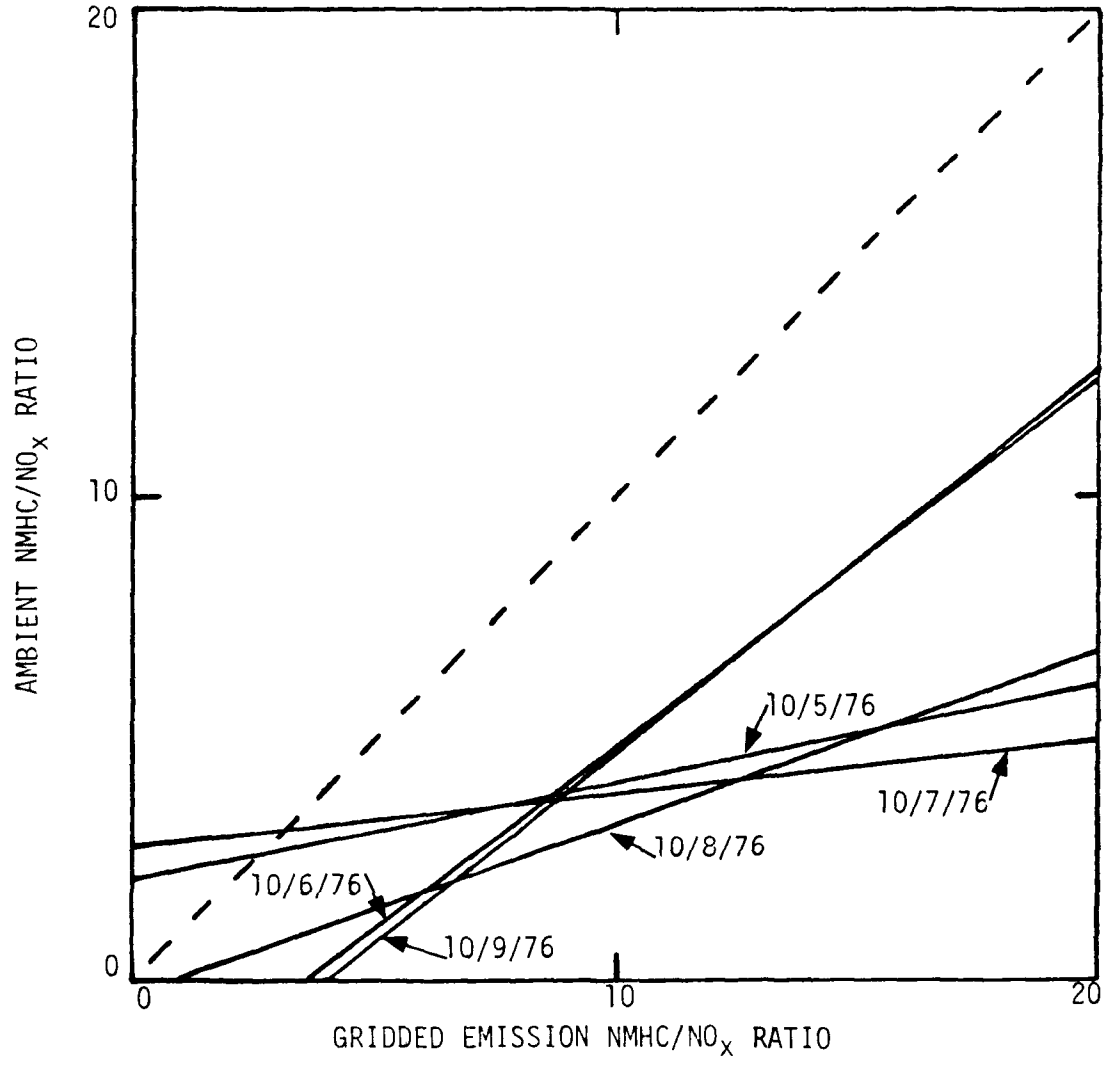

Figure 3-1. BEST-FIT REGRESSION LINES FOR FIVE HIGH-OXIDANT DAYS IN SAN FRANCISCO, COMPARING GRIDDED EMISSION NMHC/NO_x RATIOS WITH AMBIENT RATIOS. THE DASHED LINE REPRESENTS PERFECT THEORETICAL AGREEMENT.

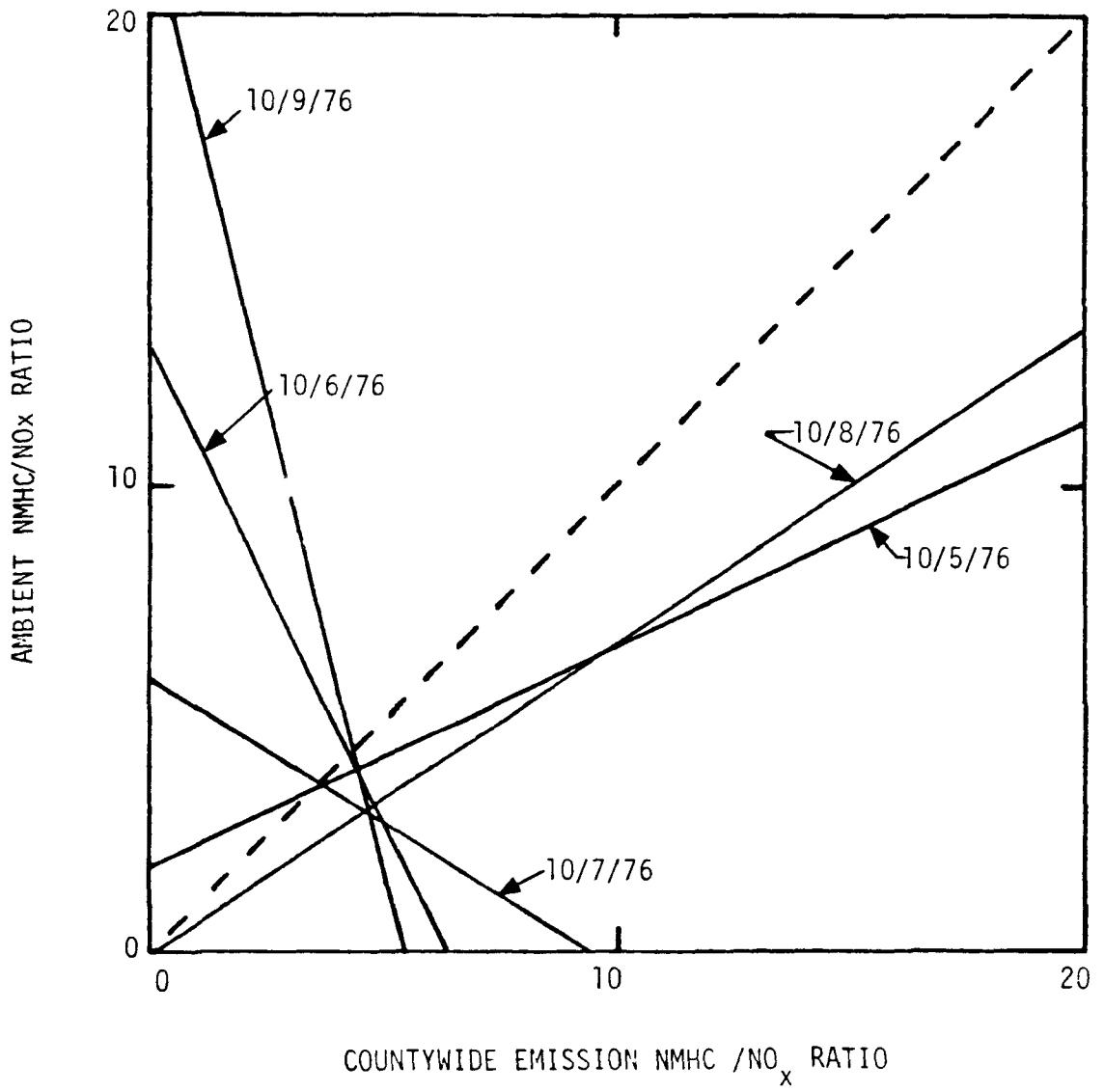

Figure 3-2. BEST-FIT REGRESSION LINES FOR FIVE HIGH-OXIDANT DAYS IN SAN FRANCISCO, COMPARING COUNTYWIDE EMISSION NMHC/NO$_x$ RATIOS WITH AMBIENT RATIOS. THE DASHED LINE REPRESENTS PERFECT THEORETICAL AGREEMENT

Although the correlations between ambient air and emission $NMHC/NO_x$ ratios were not especially significant, it is interesting to examine the numerical values of the ratios for the downtown San Francisco station, since this station might be used for an EKMA analysis over the entire San Francisco area. For this station, the gridded emission $NMHC/NO_x$ ratio was 11.64 and the countywide emission ratio was 4.08, as shown in Table 3-1. The averaged ambient air monitoring $NMHC/NO_x$ ratio for three high-oxidant days at the downtown San Francisco station, as shown in Table 3-1, was 3.81, far lower than the gridded emission ratio but only 7 percent lower than the countywide emission ratio.

4.0 ST. LOUIS DATA ANALYSIS

4.1 AMBIENT AIR MONITORING DATA

Ambient air monitoring data for St. Louis, Missouri were obtained from the St. Louis Regional Air Pollution Study (Richter 1977). Ambient air data for 24 stations in the St. Louis area were examined to find the five highest oxidant days in 1976. For these five highest oxidant days, hourly concentration values of NMHC and NO_x were averaged over the time period 6-9 a.m. (local daylight time). The averaged NMHC and NO_x concentration values were used to calculate the NMHC/NO_x ratio for each station. The ambient air monitoring data results for each day in the St. Louis area are given in Appendix C.

An examination of the individual hourly averaged data points at each station revealed that the NO_x data were very uniform and the NMHC data were more uniform than the data from Los Angeles and San Francisco. Instead of rejecting NMHC values less than 0.3 ppmC, it was decided to eliminate all hourly averaged data which showed a change greater than 100 percent from hour to hour; 17 NMHC concentration values were eliminated by this procedure. Also, it was decided to eliminate a very anomalous NMHC/NO_x ratio of 48.5 reached at station 114 on September 24, 1976. The remaining NMHC/NO_x ratios were averaged if two or more stations were in the same county. The resulting ambient air averaged ratios for the St. Louis area are shown in Table 4-1. The 6-9 a.m. ambient air monitoring NMHC/NO_x ratios ranged from a low of 1.33 to a high of 15.17, in units of ppmC/ppm.

Table 4-1. ST. LOUIS NMHC/NO_x RATIO SUMMARY

County	6-9 a.m Ambient Air Monitoring Ratio					Countywide Emission Ratio*
	8/31/76	9/5/76	9/24/76	10/1/76	10/12/76	
Madison, Ill.	6.96	15.17	-	4.20	3.45	3.05
Monroe, Ill.	1.33	10.00	5.00	14.25	2.50	3.28
St. Clair, Ill.	8.07	7.95	3.69	5.19	-	3.97
St. Charles, Mo.	-	-	4.50	-	-	1.64
St. Louis, Mo. (total)	6.65	10.19	6.66	7.39	5.29	5.12
1. St. Louis City	8.02	10.34	5.52	7.40	7.14	9.86
2. Remainder of St. Louis County	4.38	9.94	8.18	7.36	3.44	4.08

*Adjusted to represent ppmC/ppm

4.1 EMISSION INVENTORY DATA

Due to the unavailability of a detailed griddded emission inventory for the St. Louis area, only annual averaged countywide emissions were used in the data analysis. The countywide emissions were obtained from the National Emission Data System (NEDS). The emissions from one county, St. Louis County, were broken down into emissions from St. Louis City and emissions from the remainder of St. Louis County. The NEDS hydrocarbon emissions were given as total hydrocarbons; it was assumed that these emissions represented mainly NMHC emissions. The emissions for each county and the resulting adjusted NMHC/NO_x ratios (in units of ppmC/ppm) for the St. Louis area are given in Table 4-2. The countywide emission ratios ranged from a low of 1.64 to a high of 9.86. The countywide emission NMHC/NO_x ratios are compared with the ambient air monitoring ratios in Table 4-1.

Table 4-2. ST. LOUIS COUNTYWIDE EMISSION INVENTORY DATA

County	NMHC (metric tons/day)	NO_x (metric tons/day)	$NMHC/NO_x$*
Madison, Ill.	174.7	165.0	3.05
Monroe, Ill.	4.8	4.2	3.28
St. Clair, Ill.	64.6	46.9	3.97
St. Charles, Mo.	29.2	51.1	1.64
St. Louis, Mo. (total)	489.3	274.3	5.12
1. St. Louis City	171.7	50.0	9.86
2. Remainder of St. Louis County	317.6	224.3	4.08

*Adjusted to represent ppmC/ppm

4.3 RATIO COMPARISON

A linear regression analysis (Bevington 1969) was conducted on the St. Louis data in Table 4-1, comparing the county-averaged ambient air monitoring NMHC/NO_X ratios with the countywide emission ratios. The ratios for St. Louis City and the remainder of St. Louis County were treated as separate data points. The results of the regression analysis for St. Louis are shown in Table 4-3.

Except for one day, there was no significant correlation between the NMHC/NO_X ratios calculated from ambient air monitoring data and the NMHC/NO_X ratios calculated from the countywide emission inventory data. However, on October 12, 1976, the correlation coefficient was 0.98,which is significant at the 2-percent level. It is likely that this corrrelation was fortuitous, since only four data points were involved in the analysis. The regression lines for the countywide emission ratios are plotted in Figure 4-1.

Although the correlations between ambient air and emission NMHC/NO_X ratios were not especially significant, it is interesting to examine the numerical values of the ratios for St. Louis City, since these ratios might be used for an EKMA analysis over the entire St. Louis area. For St. Louis city, the countywide NMHC/NO_X emission ratio was 9.86, as shown in Table 4-1. The averaged ambient air monitoring NMHC/NO_X ratio for five high oxidant days in the St. Louis city area, as shown in Table 4-1, was 7.68, or 22 percent lower than the countywide emission ratio.

Table 4-3. ST. LOUIS NMHC/NO_x RATIO COMPARISON USING COUNTYWIDE EMISSION DATA

Date	Number of Data Points	Correlation Coefficient	Slope, a*	Intercept, b*
8/31/76	5	0.46	0.47	3.47
9/05/76	5	-0.19	-0.18	11.55
9/24/76	5	0.16	0.09	4.97
10/01/76	5	-0.07	-0.09	8.13
10/12/76	4	0.98[1]	0.62	0.98

*Linear regression equation, y=ax + b, where:
x = emission data ratio
y = ambient data ratio

[1]Significant at the 2% level

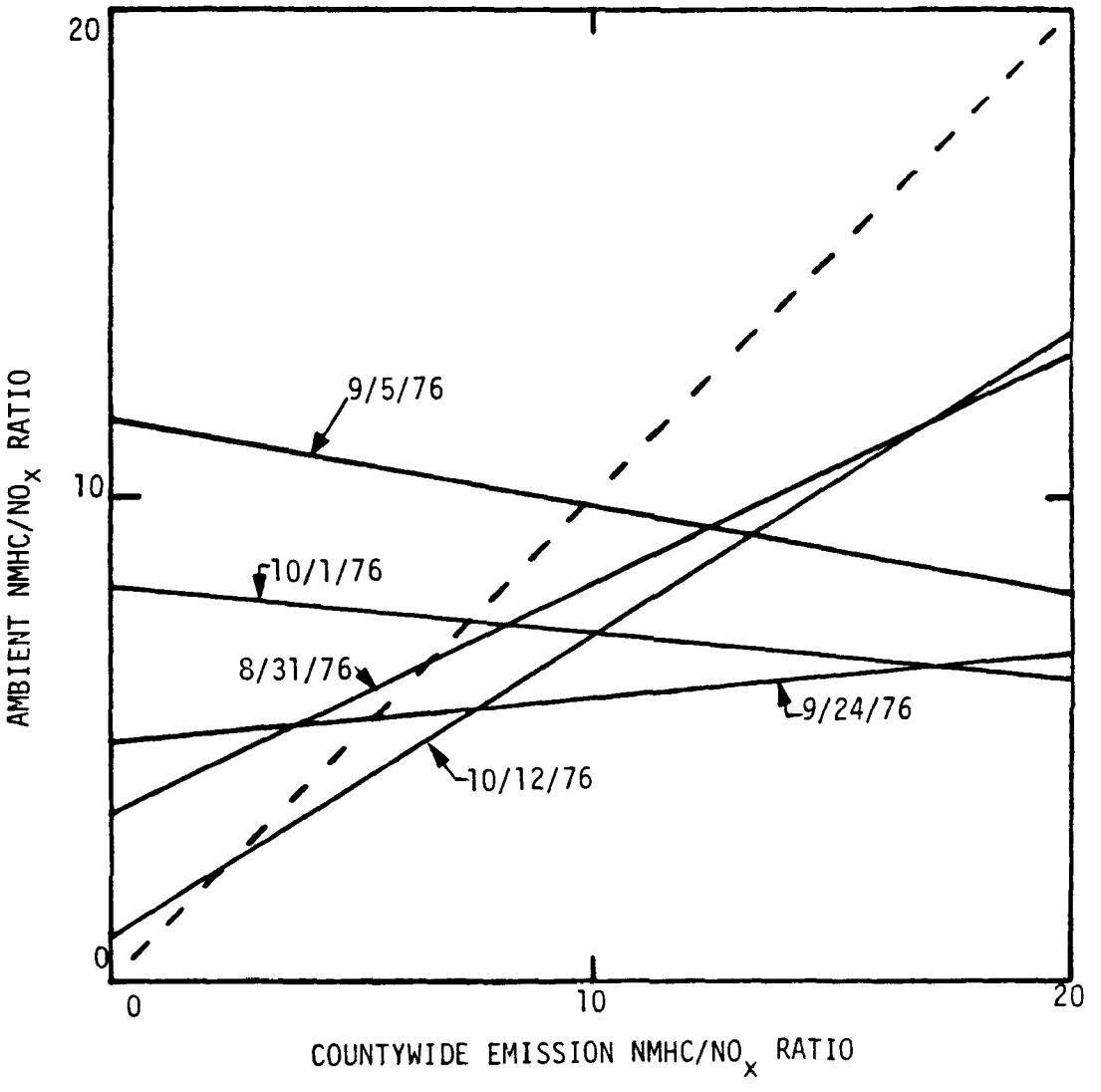

Figure 4-1. BEST-FIT REGRESSION LINES FOR FIVE HIGH-OXIDANT DAYS IN ST. LOUIS, COMPARING COUNTYWIDE EMISSION NMHC/NO_x RATIOS WITH AMBIENT RATIOS. THE DASHED LINE REPRESENTS PERFECT THEORETICAL AGREEMENT

5.0 DISCUSSION OF RESULTS

5.1 CORRELATIONS VERSUS NUMERICAL VALUES

The relationship between ambient air monitoring NMHC/NO_x ratios and emission inventory NMHC/NO_x ratios was tested by applying a linear regression analysis to ambient air and emission data from a number of air monitoring stations in a region. The relationship was tested for each of 5 high-oxidant days in each of 3 locations. The basic result found in all 3 locations - Los Angeles, San Francisco, and St. Louis - was that there was little correlation between NMHC/NO_x ratios calculated from ambient air monitoring data and the corresponding NMHC/NO_x ratios calculated from emission inventory data. There was some improvement in correlation when gridded emission ratios were used instead of countywide emission ratios in the San Francisco area, but the correlations in general were not significant.

However, since the EKMA method normally requires ambient air monitoring data from the main downtown urban center in a region, a brief analysis was made comparing the numerical values of averaged ambient NMHC/NO_x ratios with emission ratios from the central downtown areas of the 3 locations. The results are shown in Table 5-1. The gridded emission NMHC/NO_x ratio compared well with the ambient ratio in Los Angeles but poorly in San Francisco (a gridded emission inventory for St. Louis was unavailable). The countywide emission NMHC/NO_x ratio compared reasonably well with the ambient ratio in each of the 3 locations.

It is statistically possible to have poor correlation yet have numerical values be relatively close. However, it appears somewhat fortuitous that the three countywide emission NMHC/NO_x

Table 5-1. AVERAGED AMBIENT AIR NMHC/NO_X RATIOS COMPARED WITH EMISSION RATIOS IN THE CENTRAL DOWNTOWN AREA (units in ppmC/ppm)

Location	Averaged Ambient Air NMHC/NO_X	Gridded Emissions NMHC/NO_X	Countywide Emission NMHC/NO_X
Los Angeles	3.98	3.71	3.51
San Francisco	3.81	11.64	4.08
St. Louis	7.68	(no data)	9.86*

* St.Louis City only. Entire St.Louis County ratio is 5.12.

ratios matched up well with averaged ambient air ratios from the central downtown areas. For one reason, Los Angeles County has many sources over a very large area, 10,534 sq.km (4,069 sq.mi), and it seems unlikely that one air monitoring station could be representative of the entire county. Also, the gridded emission ratio for the San Francisco station, which should be more representative of the station during stagnant conditions than the countywide ratio, was 3 times greater than the ambient air ratio. Without additional work on this relationship for a larger number of cities, it cannot be recommended to use countywide emission NMHC/NO_x ratios in lieu of ambient air ratios in the EKMA method.

5.2 REASONS FOR RATIO DIFFERENCES

If emissions from one area were completely responsible for the ambient pollutant concentrations in that area, then ambient air and emission NMHC/NO_x ratios should compare favorably. However, little correlation was found in 3 different locations between NMHC/NO_x ratios calculated from ambient air monitoring data and the corresponding NMHC/NO_x ratios calculated from emission inventory data. There are a number of possible reasons for this discrepancy, which are discussed below in order of importance.

5.2.1 METEOROLOGICAL FACTORS

Probably the most important reason for the discrepancy between ambient air NMHC/NO_x ratios and emission NMHC/NO_x ratios is the great influence of meteorology on ambient pollutant concentrations. The relationship between emission rates and ambient air concentrations is quite complex, depending on many meteorological parameters such as wind speed and direction, atmospheric stability, temperature inversion heights, and horizontal and vertical diffusion rates.

The day-to-day variations in wind can advect pollutants from different regions to the location of an air monitoring station. As an example of possible variations, as shown in Table 4-1, ambient air monitoring ratios ranged from 1.3 to 14.3 during high oxidant days in one location. Even in locations which are dominated by automobile emissions, differing wind conditions on a given day could advect emissions from a major freeway to an air monitoring location, and these freeway emissions would have different NMHC/NO_x ratios than traffic emissions from surface streets. Since NMHC traffic emissions decrease

with car speed while NO_x emissions increase with speed, freeway emission NMHC/NO_x ratios may be lower than surface street ratios by a factor of two.

Also important is the transport of background pollutants from one location to another. Most air quality simulation models, which try to relate emissions to ambient air concentrations, are very sensitive to the effect of initial or background concentrations. Even the very simple linear rollback model (deNevers and Morris 1975), which assumes that pollutant concentrations are directly proportional to emission rates, considers the effect of background pollutants. Background concentrations above an inversion layer can also be entrained into a mixing layer if the inversion base rises.

5.2.2 ACCURACY OF EMISSION INVENTORY DATA

Another major reason for the discrepancy between ambient air NMHC/NO_x ratios and emission ratios is probably the lack of detail in emission inventories. Certainly annual averaged countywide emission estimates cannot be assumed to be representative of a specific day with high oxidant levels. Even detailed gridded emission inventories are normally representative only of a typical summer day and do not reflect the actual day-to-day variations which occur in a particular location.

Most emission inventories are also somewhat inaccurate or omit certain types of sources. For example, natural sources of hydrocarbons are normally emitted from most emission inventories. Also, fugitive sources of hydrocarbons, e.g., from pumps and valves in the oil and gas industries, may be omitted in inventories. The NO_x emission inventory, as well as the organic inventory, may be inaccurate; for example, the percentage of cold starts in a location greatly influences automobile NO_x emissions. However,

even if emission inventories were perfectly accurate, ambient and emission NMHC/NO_x ratios would probably still not correspond due to the influence of meteorological factors.

5.2.3 ELEVATED POINT SOURCES

Another minor reason why ambient air NMHC/NO_x ratios do not correspond to emission ratios is the fact that large elevated point sources near an air monitoring site may not impact that site significantly, since the site is at ground level while the elevated emissions may be above an inversion level. For example, in the San Francisco data analysis, the Pittsburg air monitoring station was located near a large power plant with considerable NO_x emissions. Thus, the NMHC/NO_x ratio calculated from the gridded emission inventory data was fairly low, 0.39. However, the ambient air monitoring NMHC/NO_x ratios for Pittsburg were 4.00 and 3.53, indicating that the elevated NO_x emissions were not impacting the air monitoring site significantly.

5.2.4 OTHER FACTORS

Another possible reason for the discrepancy between ambient ratios and emission ratios is the inaccuracy of the ambient air monitoring data. Nonmethane hydrocarbon concentrations are normally less reliable than NO_x concentrations, since NMHC concentrations are derived by subtracting measured methane concentrations from measured total hydrocarbon concentrations. Also, the flame ionization detector (FID) normally used for hydrocarbon measurement has different sensitivity to different types of hydrocarbons. Likewise, NO_x measurements may vary in accuracy depending on the measurement technique used. In the data analysis, all hourly NMHC concentrations were examined for uniformity, and any very low or obviously anomalous values were eliminated from the data set. However, in general, the NMHC concentration values were less consistent than the NO_x ambient monitoring values.

Another possible explanation for the lack of correlation between ambient NMHC/NO_x ratios and emission ratios is the role of photochemical reactions in changing the ambient concentrations. Both nonmethane hydrocarbons and oxides of nitrogen react significantly in photochemical smog formation. However, since the ambient air monitoring data are taken between the hours of 6 and 9 a.m., when solar radiation is low, the effect of photochemical reactions at this time on ambient concentrations should be negligible.

Since the significance of the correlation coefficient is dependent on the number of data points, the lack of correlation cannot be attributed to the small number of data points (limited by the number of monitoring stations) which were used in each analysis. However, a very restricted range of variables will normally lead to poor correlation. In most cases, this was not important, since the NMHC/NO_x ratios ranged over a factor of ten. However, the countywide emission NMHC/NO_x ratios in the San Francisco area ranged only from 2.8 to 4.5, and thus this comparison might be expected to have poor correlation.

6.0 REFERENCES

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APPENDIX A

LOS ANGELES AMBIENT AIR MONITORING DATA

Table A-1. LOS ANGELES AMBIENT MONITORING DATA - 7/11/75

Monitoring Station	County	Maximum O_3(ppm)	6-9 a.m. NMHC(ppmC)	6-9 a.m. NO_x(ppm)	NMHC/NO_x
Central Los Angeles	Los Angeles	0.18	0.90	0.22	4.09
East San Gabriel Valley	Los Angeles	0.32	0.27	0.22	1.23
East San Fernando Valley	Los Angeles	0.19	0.87	0.26	3.35
Northwest Coastal	Los Angeles	0.09	0.43	0.31	1.39
West San Fernando Valley	Los Angeles	0.22	0.50	0.19	2.63
Pomona - Walnut Valley	Los Angeles	0.32	0.47	0.21	2.24
Southeast	Los Angeles	0.17	1.57	0.16	9.81
West San Gabriel Valley	Los Angeles	0.29	0.53	0.14	3.79

Table A-2. LOS ANGELES AMBIENT MONITORING DATA - 8/02/75

Monitoring Station	County	Maximum O_3 (ppm)	6-9 a.m. NMHC (ppmC)	6-9 a.m. NO_x (ppm)	NMHC/NO_x
Central Los Angeles	Los Angeles	0.18	0.37	0.09	4.11
East San Gabriel Valley	Los Angeles	0.31	0.30	0.23	1.30
East San Fernando Valley	Los Angeles	0.21	0.57	0.08	7.13
Northwest Coastal	Los Angeles	0.09	0.10	0.02	5.00
West San Fernando Valley	Los Angeles	0.22	0.47	0.24	1.96
Pomona - Walnut Valley	Los Angeles	0.33	0.53	0.31	1.71
Southeast	Los Angeles	0.17	0.70	0.10	7.00
West San Gabriel Valley	Los Angeles	0.30	0.50	0.17	2.94

Table A-3. LOS ANGELES AMBIENT MONITORING DATA - 8/06/75

Monitoring Station	County	Maximum O_3(ppm)	6-9 a.m. NMHC(ppmC)	6-9 a.m. NO_x(ppm)	NMHC/NO_x
Central Los Angeles	Los Angeles	0.12	-	-	-
East San Gabriel Valley	Los Angeles	0.32	1.07	0.33	3.24
East San Fernando Valley	Los Angeles	0.16	1.33	0.10	13.30
Northwest Coastal	Los Angeles	0.08	0.47	0.36	1.31
West San Fernando Valley	Los Angeles	0.22	0.50	0.26	1.92
Pomona - Walnut Valley	Los Angeles	0.27	0.40	0.32	1.25
Southeast	Los Angeles	0.15	1.37	0.20	6.85
West San Gabriel Valley	Los Angeles	0.24	0.67	0.22	3.05

Table A-4. LOS ANGELES AMBIENT MONITORING DATA - 9/21/75

Monitoring Station	County	Maximum O_3 (ppm)	6-9 a.m. NMHC (ppmC)	6-9 a.m. NO_x (ppm)	NMHC/NO_x
Central Los Angeles	Los Angeles	0.16	0.77	0.18	4.28
East San Gabriel Valley	Los Angeles	0.31	0.60	0.17	3.53
East San Fernando Valley	Los Angeles	-	0.83	0.28	2.96
Northwest Coastal	Los Angeles	0.10	0.83	0.15	5.53
West San Fernando Valley	Los Angeles	0.22	0.57	0.24	2.38
Pomona - Walnut Valley	Los Angeles	0.29	0.47	0.17	2.76
Southeast	Los Angeles	0.15	1.10	0.16	6.88
West San Gabriel Valley	Los Angeles	0.26	0.50	0.09	5.56

Table A-5. LOS ANGELES AMBIENT MONITORING DATA - 10/03/75

Monitoring Station	County	O_3(ppm)	6-9 a.m. NMHC(ppmC)	6-9 a.m. NO_x(ppm)	NMHC/NO_x
Central Los Angeles	Los Angeles	0.18	1.27	0.37	3.43
East San Gabriel Valley	Los Angeles	0.31	-	-	-
East San Fernando Valley	Los Angeles	0.15	2.70	0.33	8.18
Northwest Coastal	Los Angeles	0.13	0.87	0.24	3.63
West San Fernando Valley	Los Angeles	0.11	1.00	0.32	3.13
Pomona - Walnut Valley	Los Angeles	0.19	0.87	0.21	4.14
Southeast	Los Angeles	0.24	2.77	0.44	6.30
West San Gabriel Valley	Los Angeles	0.22	0.77	0.33	2.33

APPENDIX B

SAN FRANCISCO AMBIENT AIR MONITORING DATA

Table B-1. SAN FRANCISCO AMBIENT MONITORING DATA - 10/05/76

Monitoring Station	County	Maximum O_3(ppm)	6-9 a.m. NMHC(ppmC)	6-9 a.m. NO_x(ppm)	NMHC/NO_x
Potrero	San Francisco	-	0.40	0.22	1.82
San Jose	Santa Clara	0.10	0.93	0.25	3.72
Sunnyvale	Santa Clara	0.11	0.13	0.26	0.50
Vallejo	Solano	0.10	1.33	0.57	2.33
Livermore	Alameda	0.07	1.30	0.18	7.22
Richmond	Contra Costa	0.05	0.00	0.12	0.00
Pittsburg	Contra Costa	0.09	0.60	0.15	4.00
San Rafael	Marin	0.07	0.30	0.40	0.75
Napa	Napa	0.05	0.10	0.08	1.25
Gilroy	Santa Clara	0.14	0.20	0.08	2.50
Santa Rosa	Sonoma	0.04	0.40	0.20	2.00
San Francisco	San Francisco	0.04	0.70	0.16	4.38

Table B-2. SAN FRANCISCO AMBIENT MONITORING DATA - 10/06/76

Monitoring Station	County	Maximum O_3(ppm)	6-9 a.m. NMHC(ppmC)	6-9 a.m. NO_x(ppm)	NMHC/NO_x
Potrero	San Francisco	-	-	-	-
San Jose	Santa Clara	0.10	0.97	0.22	4.41
Sunnyvale	Santa Clara	0.09	1.00	0.36	2.78
Vallejo	Solano	0.08	2.07	0.44	4.70
Livermore	Alameda	0.09	1.30	0.17	7.65
Richmond	Contra Costa	0.11	0.00	0.13	0.00
Pittsburg	Contra Costa	0.10	0.10	0.10	1.00
San Rafael	Marin	0.06	0.67	0.51	1.31
Napa	Napa	0.06	0.07	0.09	0.78
Gilroy	Santa Clara	0.10	0.30	0.08	3.75
Santa Rosa	Sonoma	0.07	0.50	0.22	2.27
San Francisco	San Francisco	0.13	1.43	0.29	4.93

Table B-3. SAN FRANCISCO AMBIENT MONITORING DATA - 10/07/76

Monitoring Station	County	Maximum O_3(ppm)	6-9 a.m. NMHC(ppmC)	6-9 a.m. NO_x(ppm)	NMHC/NO_x
Petrero	San Francisco	-	-	-	-
San Jose	Santa Clara	0.15	0.70	0.21	3.33
Sunnyvale	Santa Clara	0.11	0.95	0.20	4.75
Vallejo	Solano	0.13	0.80	0.19	4.21
Livermore	Alameda	0.12	-	-	-
Richmond	Contra Costa	0.10	0.00	0.08	0.00
Pittsburg	Contra Costa	0.14	0.53	0.15	3.53
San Rafael	Marin	0.10	0.47	0.25	1.88
Napa	Napa	0.10	0.27	0.09	3.00
Gilroy	Santa Clara	0.21	2.70	0.07	38.57
Santa Rosa	Sonoma	0.07	0.30	0.20	1.50
San Francisco	San Francisco	0.07	0.17	0.10	1.70

Table B-4. SAN FRANCISCO AMBIENT MONITORING DATA - 10/08/76

Monitoring Station	County	Maximum O_3(ppm)	6-9 a.m. NMHC(ppmC)	6-9 a.m. NO_x(ppm)	NMHC/NO_x
Potrero	San Francisco	-	-	-	-
San Jose	Santa Clara	0.10	0.43	0.19	2.26
Sunnyvale	Santa Clara	0.11	0.30	0.13	2.31
Vallejo	Solano	0.08	0.17	0.08	2.13
Livermore	Alameda	0.10	0.73	0.12	6.08
Richmond	Contra Costa	0.06	0.00	0.16	0.00
Pittsburg	Contra Costa	0.10	0.27	0.12	2.25
San Rafael	Marin	0.07	0.47	0.38	1.24
Napa	Napa	0.06	0.27	0.08	3.38
Gilroy	Santa Clara	0.13	0.20	0.06	3.33
Santa Rosa	Sonoma	0.05	0.17	0.10	1.70
San Francisco	San Francisco	0.02	0.57	0.27	2.11

Table B-5. SAN FRANCISCO AMBIENT MONITORING DATA - 10/09/76

Monitoring Station	County	Maximum O_3(ppm)	6-9 a.m. NMHC(ppmC)	6-9 a.m. NO_x(ppm)	NMHC/NO_x
Potrero	San Francisco	-	-	-	-
San Jose	Santa Clara	0.15	1.07	0.21	5.10
Sunnyvale	Santa Clara	0.11	0.37	0.13	2.85
Vallejo	Solano	0.18	-	-	-
Livermore	Alameda	0.10	0.63	0.11	5.73
Richmond	Contra Costa	0.06	0.00	0.03	0.00
Pittsburg	Contra Costa	0.15	0.73	0.15	4.87
San Rafael	Marin	0.07	0.33	0.22	1.50
Napa	Napa	0.11	0.17	0.08	2.13
Gilroy	Santa Clara	0.18	0.10	0.07	1.43
Santa Rosa	Sonoma	0.04	-	-	-
San Francisco	San Francisco	0.02	0.00	0.04	0.00

APPENDIX C

ST. LOUIS AMBIENT AIR MONITORING DATA

Table C-1. ST. LOUIS AMBIENT MONITORING DATA - 8/31/76

Monitoring Station	County	Maximum O_3 (ppm)	6-9 a.m. NMHC(ppmC)	6-9 a.m. NO_x (ppm)	NMHC/NO_x
101	St. Louis (city), Mo.	0.08	0.80	0.12	6.67
102	St. Louis (city), Mo.	0.0[illegible]	1.55	0.18	8.61
103	Madison, Ill.	0.09	0.54	0.14	3.86
104	St. Clair, Ill.	0.06	1.08	0.11	9.82
105	St. Louis (city), Mo.	0.08	0.93	0.11	8.45
106	St. Louis (city), Mo.	0.28	1.32	0.09	14.67
107	St. Louis (city), Mo.	0.02	1.07	0.13	8.23
108	Madison, Ill.	0.09	0.87	0.14	6.21
109	St. Clair, Ill.	0.10	0.34	0.07	4.86
110	St. Clair, Ill.	0.09	0.37	0.05	7.40
111	St. Louis (city), Mo.	0.08	1.14	0.14	8.14
112	St. Louis (county), Mo.	0.08	1.14	0.13	8.77
113	St. Louis (county), Mo.	0.10	0.74	0.16	4.63
114	St. Louis (county), Mo.	0.03	0.54	0.12	4.50
115	Madison, Ill.	0.11	-	-	-
116	Madison, Ill.	0.08	0.33	0.04	8.25
117	St. Clair, Ill.	0.08	0.21	0.03	7.00
118	Monroe, Ill.	0.09	0.04	0.03	1.33
119	St. Louis (county), Mo.	0.08	0.32	0.08	4.00
120	St. Louis (county), Mo.	0.10	0.87	0.15	5.80
121	St. Louis (county), Mo.	0.09	-	-	-
122	Madison, Ill.	0.13	0.38	0.04	9.50
124	Monroe, Ill.	-	-	-	-
125	St. Charles, Mo.	0.09	-	-	-

Table C-2. ST. LOUIS AMBIENT MONITORING DATA - 9/05/76

Monitoring Station	County	Maximum O_3(ppm)	6-9 a.m. NMHC(ppmC)	6-9 a.m. NO_x(ppm)	NMHC/NO_x
101	St. Louis (city), Mo.	0.08	-	-	-
102	St. Louis (city), Mo.	0.08	0.47	0.06	7.83
103	Madison, Ill.	0.26	0.37	0.03	12.33
104	St. Clair, Ill.	0.06	0.43	0.05	8.60
105	St. Louis (city), Mo.	0.08	0.31	0.05	6.20
106	St. Louis (city), Mo.	0.08	0.90	0.07	12.86
107	St. Louis (city), Mo.	0.07	0.71	0.05	14.20
108	Madison, Ill.	0.08	0.54	0.03	18.00
109	St. Clair, Ill.	0.08	0.46	0.07	6.57
110	St. Clair, Ill.	0.08	0.52	0.06	8.67
111	St. Louis (city), Mo.	0.08	0.53	0.05	10.60
112	St. Louis (county), Mo.	0.08	0.37	0.04	9.25
113	St. Louis (county), Mo.	0.10	-	-	-
114	St. Louis (county), Mo.	0.10	1.49	0.02	74.50
115	Madison, Ill.	-	-	-	-
116	Madison, Ill.	0.02	-	-	-
117	St. Clair, Ill.	0.08	-	-	-
118	Monroe, Ill.	0.11	0.40	0.04	10.00
119	St. Louis (county), Mo.	0.08	0.35	0.04	8.75
120	St. Louis (county), Mo.	0.09	0.71	0.06	11.83
121	St. Louis (county), Mo.	0.08	-	-	-
122	Madison, Ill.	0.08	-	-	-
124	Monroe, Ill.	0.08	0.07	0.01	7.00
125	St. Charles, Mo.	0.10	-	-	-

Table C-3. ST. LOUIS AMBIENT MONITORING DATA - 9/24/76

Monitoring Station	County	Maximum O_3 (ppm)	6-9 a.m. NMHC(ppmC)	6-9 a.m. NO_x (ppm)	NMHC/NO_x
101	St. Louis (city), Mo.	0.05	0.61	0.06	10.17
102	St. Louis (city), Mo.	0.06	0.10	0.04	2.50
103	Madison, Ill.	0.25	-	-	-
104	St. Clair, Ill.	0.05	0.47	0.10	4.70
105	St. Louis (city), Mo.	0.07	0.20	0.05	4.00
106	St. Louis (city), Mo.	0.06	1.04	0.09	11.56
107	St. Louis (city), Mo.	0.04	-	-	-
108	Madison, Ill.	0.06	1.13	0.03	37.67
109	St. Clair, Ill.	0.07	0.04	0.02	2.00
110	St. Clair, Ill.	0.08	0.08	0.03	2.67
111	St. Louis (city), Mo.	0.07	0.27	0.05	5.40
112	St. Louis (county), Mo.	0.05	0.49	0.05	9.80
113	St. Louis (county), Mo.	0.05	-	-	-
114	St. Louis (county), Mo.	-	0.97	0.02	48.50
115	Madison, Ill.	0.06	-	-	-
116	Madison, Ill.	0.06	-	-	-
117	St. Clair, Ill.	0.07	-	-	-
118	Monroe, Ill.	0.09	-	-	-
119	St. Louis (county), Mo.	0.07	0.20	0.04	5.00
120	St. Louis (county), Mo.	-	0.39	0.04	9.75
121	St. Louis (county), Mo.	0.08	-	-	-
122	Madison, Ill.	0.06	0.03	0.003	10.00
124	Monroe, Ill.	0.07	0.05	0.01	5.00
125	St. Charles, Mo.	0.11	0.09	0.02	4.50

Table C-4. ST. LOUIS AMBIENT MONITORING DATA - 10/01/76

Monitoring Station	County	Maximum O_3(ppm)	6-9 a.m. NMHC(ppmC)	6-9 a.m. NO_x(ppm)	NMHC/NO_x
101	St. Louis (city), Mo.	0.24	-	-	-
102	St. Louis (city), Mo.	0.24	1.93	0.34	5.68
103	Madison, Ill.	0.20	0.97	0.18	5.39
104	St. Clair, Ill.	0.20	-	-	-
105	St. Louis (city), Mo.	0.01	1.94	0.18	10.78
106	St. Louis (city), Mo.	0.22	1.45	0.17	8.53
107	St. Louis (city), Mo.	0.21	2.26	0.30	7.53
108	Madison, Ill.	0.15	1.50	0.27	5.56
109	St. Clair, Ill.	0.18	0.00	0.15	0.00
110	St. Clair, Ill.	0.22	0.55	0.08	6.88
111	St. Louis (city), Mo.	0.20	1.03	0.23	4.48
112	St. Louis (county), Mo.	0.14	0.65	0.12	5.42
113	St. Louis (county), Mo.	0.20	-	-	-
114	St. Louis (county), Mo.	0.16	1.40	0.21	6.67
115	Madison, Ill.	0.16	0.35	0.10	3.50
116	Madison, Ill.	0.14	0.14	0.06	2.33
117	St. Clair, Ill.	0.14	0.14	0.04	3.50
118	Monroe, Ill.	0.24	0.66	0.03	22.00
119	St. Louis (county), Mo.	0.12	0.90	0.09	10.00
120	St. Louis (county), Mo.	-	-	-	-
121	St. Louis (county), Mo.	0.10	-	-	-
122	Madison, Ill.	-	-	-	-
124	Monroe, Ill.	0.08	0.57	0.04	14.25
125	St. Charles, Mo.	0.08	-	-	-

Table C-5. ST. LOUIS AMBIENT MONITORING DATA - 10/12/76

Monitoring Station	County	Maximum O$_3$ (ppm)	6-9 a.m. NMHC(ppmC)	6-9 a.m. NO_x(ppm)	NMHC/NO_x
101	St. Louis (city), Mo.	0.06	-	-	-
102	St. Louis (city), Mo.	0.06	0.84	0.13	6.46
103	Madison, Ill.	0.25	-	-	-
104	St. Clair, Ill.	0.06	1.16	0.05	23.20
105	St. Louis (city), Mo.	0.02	-	-	-
106	St. Louis (city), Mo.	0.07	0.71	0.10	7.10
107	St. Louis (city), Mo.	0.06	1.10	0.14	7.86
108	Madison, Ill.	0.07	0.37	0.09	4.11
109	St. Clair, Ill.	0.07	-	-	-
110	St. Clair, Ill.	0.06	-	-	-
111	St. Louis (city), Mo.	0.06	0.53	0.11	4.82
112	St. Louis (county), Mo.	0.01	0.38	0.13	2.92
113	St. Louis (county), Mo.	0.07	0.41	0.12	3.42
114	St. Louis (county), Mo.	0.07	0.91	0.07	13.00
115	Madison, Ill.	-	0.06	0.03	2.00
116	Madison, Ill.	0.07	-	-	-
117	St. Clair, Ill.	0.07	-	-	-
118	Monroe, Ill.	0.08	0.02	0.01	2.00
119	St. Louis (county), Mo.	0.01	0.12	0.05	2.40
120	St. Louis (county), Mo.	0.07	0.78	0.05	15.60
121	St. Louis (county), Mo.	-	0.35	0.07	5.00
122	Madison, Ill.	0.08	0.17	0.04	4.25
124	Monroe, Ill.	0.07	0.03	0.01	3.00
125	St. Charles, Mo.	-	-	-	-

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
EPA-450/3-78-026		

4. TITLE AND SUBTITLE	5 REPORT DATE
COMPARISON OF AMBIENT NMHC/NO_x RATIOS WITH NMHC/NO_x RATIOS CALCULATED FROM EMISSION INVENTORIES	June 1978
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT NO.
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U.S. Environmental Protection Agency Office of Air and Waste Management Office of Air Quality Planning and Standards Research Triangle Park, North Carolina 27711	Final 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

16 ABSTRACT

The Empirical Kinetic Modeling Approach (EKMA) requires the determination of the ratio of nonmethane hydrocarbons (NMHC) to oxides of nitrogen (NO_x). Three geographic locations were used in analyzing the differences between NMHC/NO_x ratios calculated from emission inventory data and those from ambient monitoring data. The three locations were: Los Angeles, California; San Francisco, California; and St. Louis, Missouri.

The relationship between ambient monitoring NMHC/NO_x ratios and emission inventory NMHC/NO_x ratios was tested by applying a linear regression analysis to air quality and emission data from a number of monitoring stations in each region. The relationship was tested for each of five high-oxidant days in each of the three locations. The basic result found in all three locations was that there was little correlation between NMHC/NO_x ratios calculated from ambient monitoring data and the corresponding NMHC/NO_x ratios calculated from emission inventory data

17. KEY WORDS AND DOCUMENT ANALYSIS

a DESCRIPTORS	b IDENTIFIERS/OPEN ENDED TERMS	c COSATI Field/Group
Air Pollution Hydrocarbons Nitrogen Oxides Ozone		4B 7A 13B

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