AIR QUALITY DATA USED IN MODEL VALIDATION

Appendix E

of

Development of a Simulation Model
for Estimating Ground Level Concentrations
of Photochemical Pollutants

Prepared by

Systems Applications, Inc.
Beverly Hills, California 90212

for the

Air Pollution Control Office
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CONTENTS

INTRODUCTION

Validation of an urban airshed model consists in demonstrating that predictions and experimental measurements of ground level contaminant concentrations compare favorably over a wide variety of conditions. Ideally, such comparisons should be made using data collected throughout the course of a "validation day," at a number of locations covering the air basin. Furthermore, *several days* should be selected for study such that all meteorological conditions typical of the airshed are represented. In the summertime, for example, Los Angeles experiences the effects of a semi-permanent anticyclone lying off the coast--low to moderate westerly winds, a strong subsidence inversion, and the virtual absence of cloud cover (and thus, strong solar insolation). From time to time, however, Santa Ana conditions prevail--hot, dry winds emanating from the desert to the east. A truly satisfactory model must demonstrate reasonable agreement between predicted and measured concentrations throughout the course of a day for these, as well as other, expected meteorological conditions.

Due to restrictions in time and funding, and because this project represents only an initial attempt to develop an acceptable airshed model, we have substantially limited the scope of this validation effort. In particular, we have selected only two days to serve as "validation days"--Monday, September 29, and Tuesday, September 30, 1969. It is our expectation, however, that a more comprehensive validation program will be undertaken before the model is "accepted."

Two factors were paramount in the selection of the two validation days. First, meteorological conditions typical of a smoggy summer day in Los Angeles prevailed. Second, a particularly rich data base exists for these days with respect to both air quality and meteorology. In addition to the routine collection of contaminant concentration data at fourteen ground sites in the Basin by the Los Angeles and Orange County Air Pollution Control Districts, chemical analyses were made of air samples obtained aloft by both airplane and helicopter. Also, Scott Research Laboratories operated two additional monitoring stations during this period, and they have provided an air quality record that is particularly detailed in the characterization of hydrocarbons. Finally, the days selected are two of only fourteen in 1969 on which vertical temperature soundings were taken not only at Los Angeles International Airport, but also at three additional locations in the basin. These soundings provide far more detailed information concerning the nature of the inversion than is commonly available.

The stated goal of the model development effort is the accurate prediction of pollutant concentrations at ground level. Thus, emphasis was placed on validation with respect to this portion of the data base. Air quality data collected aloft are less useful, as little is known about wind speed and direction at elevations greater than about 30 feet above the ground. While the prediction of concentrations aloft is not a justifiable undertaking under these circumstances, the data still have value, in that they provide insight into several atmospheric phenomena of interest. These include the possible presence of air parcels bearing pollutants formed on previous days, the magnitude of vertical eddy diffusivities, and variations in the rates of production of secondary pollutants with elevation (an effect attributable to the absorption and scattering of incoming radiation by atmospheric pollutants).

This Appendix is devoted to the presentation and summarization of available air quality data for September 29 and 30, 1969. In Section I we describe the ground level contaminant monitoring network of the Los Angeles Basin and survey the methods employed in the acquisition of air quality data. We then present the relevant data for September 29 and 30, 1969. In Section II, the airborne data collection program is described.

I. AIR QUALITY DATA AT GROUND LEVEL

This discussion focuses on the air quality data collected at ground stations throughout the Los Angeles Basin and used in the validation of the airshed model. In Part A of this section the ground level contaminant monitoring network is described. The sampling and chemical analysis procedures employed at the monitoring stations are discussed in Part B. Finally, in Part C, the air quality data for the validation days are presented.

A. Contaminant Monitoring Network

In September 1969, the contaminant monitoring network of the Los Angeles Basin consisted of eleven stations operated by the Los Angeles County Air Pollution Control District and three operated by the Orange County Air Pollution Control District. All of these stations, except one, are located inside the 50 mile square modeling area. The Pomona station, in Los Angeles County, is situated approximately one mile east of the eastern boundary of the modeling area. In addition, the Scott Research Laboratories, under contract to the Coordinating Research Council, made comprehensive measurements of ground level contaminant concentrations during this period at two locations in the basin. The locations of the sixteen monitoring stations are shown on Figure E-1 and their street addresses in Table E-1. As several of the monitoring stations are located near major sources of contaminants (freeways, power plants, airports, refineries), we present in Table E-2 a brief description of the locale in the immediate vicinity of each station. The contaminants measured at each station are identified in Table E-3.

B. Sampling and Measurement Procedures

The placement and positioning of air sampling probes by the Los Angeles and Orange County Air Pollution Control Districts has been largely standardized. Probes are usually mounted on single-story

Figure E-1 and
Tables E-1 to E-3 follow

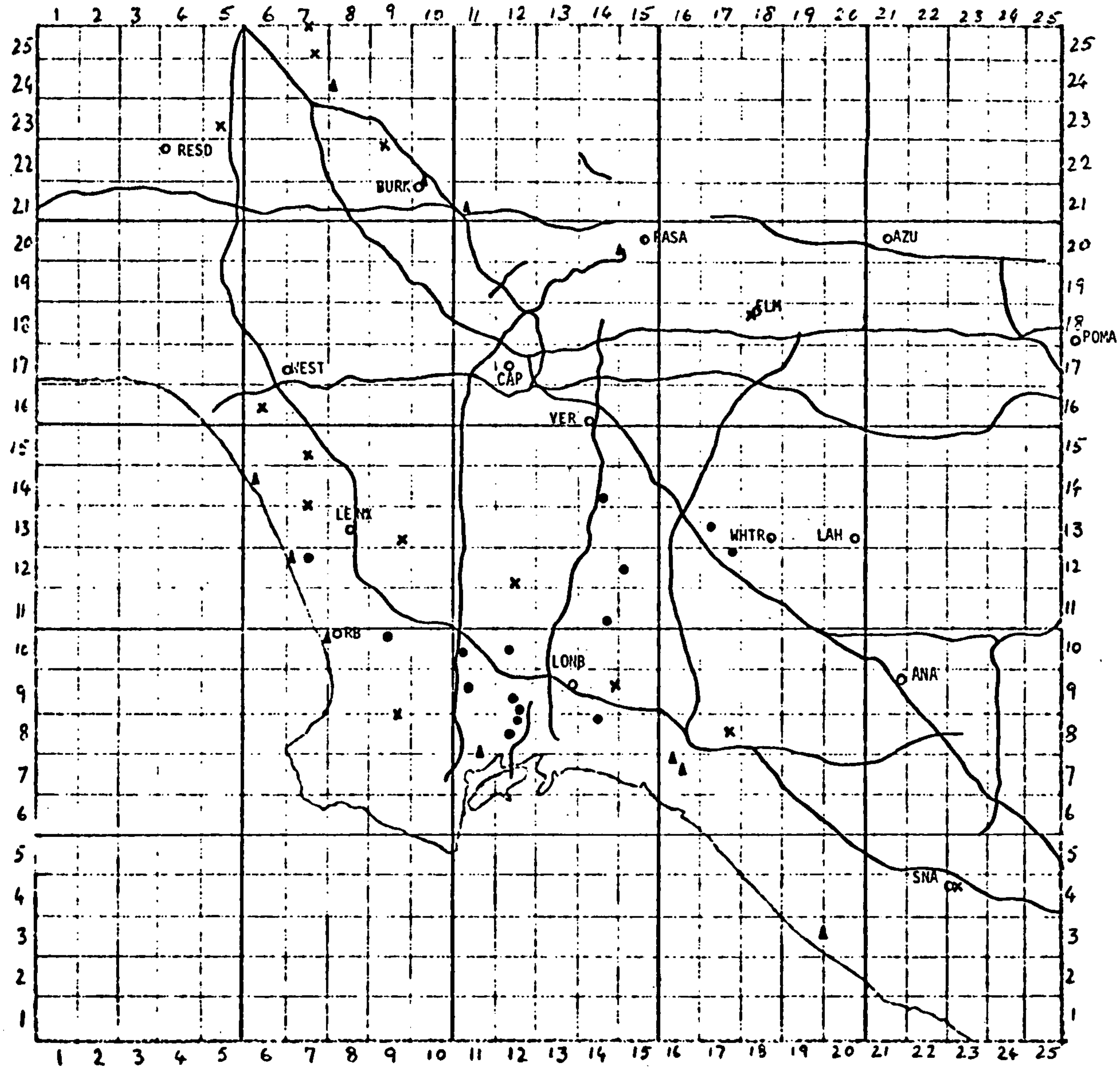


Figure E-1. Locations of Monitoring Stations Relative to Major Contaminant Sources in the Los Angeles Basin

- ⌐ – freeways
- • – oil refineries
- ▲ – power plants
- x – airports
- o – contaminant monitoring stations

Table E-1. Addresses and Locations of Contaminant Monitoring Stations in the Los Angeles Basin

Station Number	Station Code Name	Address
1	CAP	434 S. San Pedro Street, Los Angeles (at 4th Street)
60	AZU	803 N. Loren Avenue, Azusa (two blocks north of Foothill Boulevard)
69	BURK	228 W. Palm Avenue, Burbank (at Victory Boulevard)
71	WEST	2351 Westwood Boulevard, Los Angeles (1/2 block north of Pico Boulevard)
72	LONB	3648 N. Long Beach Boulevard, Long Beach (at 36th Street)
74	RESD	18330 Gault Street, Reseda (at Etiwanda Avenue)
75	POMA	924 N. Garey Avenue, Pomona (at Kingsley Street)
76	LENX	11408 La Cienega Boulevard, Los Angeles (at Imperial Boulevard)
78	RB	615 E. Anita Street, Redondo Beach (at Pacific Coast Highway)
79	PASA	1201 E. California Boulevard, Pasadena (at Wilson Avenue)
80	WHTR	14427 Leffingwell Road, Whittier (at Telegraph Road)
OC1	ANA	1010 S. Harbor Boulevard, Anaheim (at Vermont Avenue)
OC2	SNA	Paulorino Avenue, Near Airport Control Tower, Orange County Airport, Santa Ana
OC3	LAH	621 Ocean Avenue, La Habra (at Walnut Street)
Scott Research	ELM	El Monte Airport
Scott Research	VER	4545 E. Washington Boulevard, City of Commerce (at Long Beach Freeway)

Table E-2. Siting of Contaminant Monitoring Stations in the Los Angeles Basin

Station Number	Station Code Name	
1	CAP	Surrounded by four freeways, approximately one mile from each. Sampling probe is suspended outside a sixth-floor window.
60	AZU	Approximately 3/8 mile north of Foothill Freeway.
69	BURK	Approximately 150 meters southwest of Burbank power plant and 300 meters southwest of Golden State Freeway.
71	WEST	Approximately 1/4 mile northeast of San Diego Freeway and 1/4 mile north of Santa Monica Freeway. Wind direction is predominantly southwest during the day; the station is thus affected by the freeways.
72	LONB	Approximately 200 meters north of San Diego Freeway. Wind direction is predominantly south during the day; the station will be affected by freeway at these times.
74	RESD	Approximately 2 miles north of Ventura Freeway.
75	POMA	Approximately 1/3 mile south of San Bernardino Freeway.
76	LENX	Immediately west of San Diego Freeway and immediately southeast of Los Angeles International Airport. Wind direction is predominantly southwest, however, so station should not be unduly affected by these sources.
78	RB	Approximately 300 meters northeast of Redondo Beach power plant. Station measures only SO_2.
79	PASA	Approximately 1 1/4 miles east/northeast of Pasadena power plant. Station may be affected by power plant during the day.
80	WHTR	Located on main street; no other major sources near site.
OC1	ANA	Approximately 200 meters northeast of Santa Ana Freeway.
OC2	SNA	Approximately 150 meters west/northwest of runway at Orange County Airport and 1/4 mile south of San Diego Freeway. Station is probably affected by aircraft emissions.
OC3	LAH	No major sources near site.
Scott Research	ELM	At El Monte Airport and approximately 1 mile north of San Bernardino Freeway.
Scott Research	VER	Less than 100 meters west of Long Beach Freeway and 1 mile south of Santa Ana Freeway.

Table E-3. Contaminants Measured at Each of the Los Angeles Basin Monitoring Stations During September 1969

Station \ Contaminant*	Total Oxidant	CO	SO_2	NO_2	NO	NO + NO_2	HC, as Methane	Methane
CAP 1	X	X	X	X	X	X	X	X
AZU 60	X	X		X	X	X	X	X
BURK 69	X	X	X	X	X	X		
WEST 71	X	X	X	X	X	X		
LONB 72	X	X	X	X	X	X		
RESD 74	X	X	X	X	X	X		
POMA 75	X	X	X	X	X	X		
LENX 76	X	X	X	X	X	X		
RB 78			X					
PASA 79	X		X	X	X	X	X	X
WHTR 80	X	X		X	X	X		
ANA OC1	X		X	X		X	X	
SNA OC2	X		X					
LAH OC3	X		X	X		X		
ELM**	X	X		X	X		X	
VER**	X	X		X	X		X	

*Contaminants measured at each station are identified with an (X).
**Periodic measurements of individual hydrocarbons and continuous measurements of ozone were made at these stations.

buildings such that the probe height is approximately 20 feet above the ground. In most instances, the distance from the roof-top to the probe is about four feet. However, greater separations are required in a few cases to compensate for the potential interference of surrounding parapets.

Contaminants for which statewide air quality standards exist are measured at the County monitoring stations using procedures recommended by the State of California Air Resources Board. All contaminants are monitored on a continuous basis, with readings from the measuring instruments recorded on strip charts. We list below, for each contaminant, the method of chemical analysis employed by the Air Pollution Control Districts of Los Angeles and Orange Counties and comment briefly on the specificity of the procedure.

<u>Total Oxidant</u>

Color change in a 10% buffered potassium iodide solution. About 90% of the iodine is liberated by ozone immediately; oxidants other than ozone will also liberate iodine but at a slower rate. The air sample is not filtered prior to passing through the instrument, and any substance present which liberates iodine in the solution will be recorded as oxidant. In particular, NO_2 will increase the readings by an amount equal to about 10% of the NO_2 concentrations present, and SO_2 will decrease the readings by an amount approximately equal to the SO_2 concentration.

<u>Carbon Monoxide</u>

Infrared absorption. The air sample is dried to remove water vapor and filtered to remove small particles. As there are no other substances present in the atmosphere in appreciable quantities which absorb in that portion of the infrared region which is monitored, the method is highly specific.

<u>Oxides of Nitrogen</u>

Color change in a modified Saltzman reagent. NO_2 is measured directly. NO is measured as NO_2 after being oxidized by passing the sample through a potassium permanganate solution. However, some of the NO present may not be converted to NO_2. The presence of other gases in the sample causes only slight interference.

<u>Total Hydrocarbons</u>

Flame ionization. Any substance which ionizes will be recorded, including oxygenated hydrocarbons and most other organic compounds.

For further discussion of these methods, reference should be made to the literature on the subject. Particularly valuable are the review articles of Katz (1968) and Altshuller (1968).

Two fully instrumented trailers, sited at Commerce and El Monte, were used by Scott Research in their data collection program. A list of the procedures used follows. The specificity of some of the methods have been discussed previously and are not repeated here.

Total Oxidants

Current flow as a result of the electrolytic reaction of oxidants and potassium iodide. A Mast Model 724-2 ozone recorder was used to make the measurements. This instrument responds to all oxidants and is accurate to about 2%. In addition, the Commerce trailer was equipped with a Beckman Model K-78 Acralyzer, which measures total oxidant by monitoring color change in a potassium iodide solution. This instrument is accurate to about 5%.

Ozone

Same as for total oxidants, using Mast recorder. The equipment is made specific to ozone by means of olefin titration apparatus.

Carbon Monoxide

Infrared absorption (Commerce trailer). A Beckman Model 315 AL infrared analyzer was used. This apparatus was equipped with an optical filter to eliminate interference from water vapor.

Gas Chromatography (El Monte trailer). A Varian-Aerograph Model 1532-2B gas chromatograph equipped with helium ionization detectors was used.

Oxides of Nitrogen

Color change in a modified Saltzman solution. At the Commerce site a Beckman Model K-75 Acralyzer was used with N(1-naphthyl, acetyl) ethylenediamine substituted for the coupling compound supplied. Also, the potassium permanganate solution used to oxidize NO to NO_2 was replaced with more efficient chromic oxide-impregnated glass fiber filters. Manual analyses of air samples were made at both Commerce and El Monte, the color changes being measured with a Bausch and Lomb Spectronic 20 spectrophotometer.

Total Hydrocarbons

Flame ionization. Beckman Model 108A and 109A total hydrocarbon analyzers were used. These instruments are accurate to about 1%.

Individual C_1 to C_{10} Hydrocarbons

Gas chromatography. A Perkin-Elmer Model 900 gas chromatograph with dual flame ionization detectors was used.

See Scott Research (1970) for further details concerning the sampling and analytical procedures employed.

C. Air Quality Data for 29 and 30 September 1969

Ground level contaminant concentrations measured by Los Angeles and Orange County APCD'S for 29 and 30 September 1969 are summarized in Tables E-4 to E-10. (Table E-8 was derived directly from the contents of Tables E-6 and E-7.) These concentrations are reported as hourly averages, the average being taken over the hour immediately following. For example, concentrations listed at 8:00 a.m. are averages of concentrations measured during the period, 8:00 a.m. to 9:00 a.m. In contrast, Scott Research reported their data as ten minute averages at ten minute time intervals over 24 hours. Although their instrumentation monitored all pollutants on a continuous basis, they recorded data at one minute intervals during daytime working hours and at ten minute intervals overnight. Records of data which were collected manually were inserted into the appropriate time period. We have summarized the relevant data obtained by Scott Research as hourly averages, the average again being taken over the hour immediately following in order to present the data in the same manner as did the County authorities. The data obtained at the Commerce and El Monte sites on 29 and 30 September 1969 are shown in this reduced form in Tables E-12 and E-13. Reference should be made to Scott Research (1970) for a complete data listing, and to Eschenroeder and Martinez (1970) for a discussion of the data obtained.

An important part of the Scott data collection and analysis program was the identification of individual C_1 to C_{10} hydrocarbons and the determination of hydrocarbon composition for air samples which were obtained at time intervals of between one and four hours. Of a total of 120 peaks observed on the chromatograph in the course of these analyses, 59 individual hydrocarbons were identified. We have classified these 59 hydrocarbons as being reactive or unreactive, using a classification scheme similar to that used by the Los Angeles County APCD. The peak numbers of the hydrocarbons and associated reactivity classification are shown in Table E-14. A total of 19 air samples collected on the two validation days were analyzed; a typical analysis is shown in Table E-15. Again, reference should be made to the Scott report for the complete data.

II. AIR QUALITY DATA ALOFT

We have commented earlier on the uses and limitations of the air quality data collected aloft in the validation of the airshed model.

Tables E-4 to E-15 follow

Table E-4. Oxidant Concentrations Measured by Los Angeles and Orange County Air Pollution Control Districts on 29 and 30 September 1969*

Hour PST (29 September 1969)

Station	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	1	1	1	1		1	1	2	5	8	12	9	8	7	5	3	2	1	1	1	1	1	1	1
60	2	2	2	2		2	2	3	9	16	22	24	28	38	25	14	7	2	1	1	1	1	1	1
69	1	1	1	1		1	1	2	4	7	11	14	21	14	11	5	3	2	2	1	1	1	1	1
71	1	1	1	2		1	1	1	3	5	10	12	10	10	6	4	2	1	3	1	1	1	1	1
72	1	1	1	2		1	1	1	1	2	2	6	2	1	1	1	1	1	1	2	2	1	1	1
74	2	1	1	1		2	4	4	9	12	14	10	17	9	6	7	4	3	2	1	1	1	1	1
75	3	3	3	2		2	2	3	9	16	19	14	15	21	21	16	6	6	3	2	2	2	2	2
76	1	2	3	3		1	1	2	2	3	4	10	7	8	5	4	4	4	1	1	2	1	1	1
79	3	2	2	2		2	2	2	9	17	26	41	32	20	12	9	6	3	2	2	2	2	2	2
80	1	1	1	1		1	1	2	6	11	21	34	30	19	12	7	4	5	3	2	1	1	1	1
OC1	0	1	1	0		2	0	0	3	7	15	31	34	22	17	9	6	3	1	1	1	1	0	0
OC2	1	1	1	1	1	0	0	0	1	7	16	17	19	12	11	8	5	3	2	2	2	1	1	1
OC3	0	0	0	0	0	0	0	0	2	7	14	28	35	25	11	7	4	2	0	0	0	0	0	0

Hour PST (30 September 1969)

Station	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	1	1	1	1		1	1	3	7	8	15	22	15	17	13	6	5	4	2	2	2	1	1	2
60	1	1	1	1		1	1	3		7	13	17	18	27	19	15	12	7	3	2	2	2	2	2
69	1	1	1	1		1	1	2	4	6	12	20	20	10	9	8	4	2	2	1	1	1	1	1
71	1	1	1	1		1	1	1	1	2	4	1	9	13	10	5	3	2	1	1	1	1	1	1
72	1	1	1	1		1	1	1	1	1	2	2	3	7	10	7	1	2	1	1	1	1	1	1
74	1	1	1	1		1	1	2				8	10	9	8	5	5	3	1	1	1	1	1	1
75	2	1	1	1		1	1	3	5	7	10	16	16	15	9	14	11	9	4	3	2	2	2	2
76	1	1	1	1		1	1	1	1	1	1	2	7	7	9	4	3	2	1	2	2	2	2	2
79	2	2	2	1		1	1	3	7	16	20	23	36	22	20	15	13	6	3	3	2	2	2	2
80	1	1	1	1		1	1	2	4	7	8	10	3	5	7	8	6	5	2	2	2	2	2	1
OC1	0	2	2	2		2	2	2	3	7	12	13	11	10	14	11	11	8	4	3	3	3	2	2
OC2	1	1	1	1	1	1	1	1	2	2	4	6	7	7	7	7	8	7	3	2	1	2	1	1
OC3	0	0	0	0	0	0	0	0	0	2	6	7	4	2	6	7	6	3	1	0	0	0	0	0

*Concentrations in pphm.

Table E-5. Carbon Monoxide Concentrations Measured by Los Angeles County Air Pollution Control District on 29 and 30 September 1969*

Station	Hour PST (29 September 1969)																							
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	1	1	1	1	2	3	7	17	18			6	3	3	2	6	6	5	4	7	4	4	6	9
60	9	10	9	9	9	10	10	10	11	10	8	6	7	9	6	6	4	5	7	7	7	8	9	11
69	9	9	10	11	12	13	15	18	17	9	11	10	11	7	7	5	5	6	12	16	14	16	15	14
71	4	4	3	3	6	5	9	17	17	8		5	4	4	4	4	5	4	4	4	5	5	6	8
72	2	3	2	2	3	7	9	13	11	9	6	6	6	5	5	5	5	5	4	4	4	5	6	5
74	15	13	9	10	9	10	12	16	11	8	6	4	5	3	3	5	5	5	6	7	8	8	8	11
75	8	7	7	7	7	7	8	9	9		6	5	4	5	6	6	6	5	6	5	7	11	10	9
76	5	3	3	3	4	6	15	9	5	5	6		3	3	4	6	6	5	3	4	3	4	3	3
80	5	5	5	4	6	7	11	14	11	11	13		2	1	1	1	1	1	1	3	4	5	5	7

Station	Hour PST (30 September 1969)																							
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	12	13	15	14	13	19	28	30	32	18		12	6	4	4	7	8	4	4	4	5	7	8	9
60	10	10	9	9	8	8	9	11		7	6	6	5	5	5	5	5	5	6	7	8	9	9	9
69	14	15	16	16	16	16	21	23	17	14	21	18	13	8	5	6	7	8	9	9	10	11	11	11
71	9	8	8	6	6	8	16	16	11	6	5		4	5	3	3	3	3	4	6	6	8	10	10
72	4	4	3	3	3	7	12	20	13		9	7	7	8	6	7	7	6	5	5	7	8	5	5
74	11	11	9	8	6	7	13	19	15	5	4	3	3	3	3	4	5	6	10	12	14	11	11	10
75	9	7	3	3	3	4	7	9	6		5	6	5	5	6	7	6	6	7	8	12	11	9	9
76	5	3	2	4	8	12	16	12	5	5	5	4	4		5	5	5	3	3	3	4	4	5	6
80	6	4	5	6	7	11	19	9	7	6			4	4	4	5	5	5	5	5	6	7	6	6

*Concentrations in ppm.

Table E-6. Nitrogen Dioxide Concentrations Measured by Los Angeles and Orange County Air Pollution Control Districts on 29 and 30 September 1969*

Hour PST (29 September 1969)

Station	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	5	6	6	6	5	4	2	3	11	19	18	10			5	6	7	7	5	4	4	4	3	5
60	13	15	14	13	13	12	12	13	16	11	8	5				5	7	7	11	13	11	11	10	10
69	13	12	12	13	14	15	15	17	25	29	28	19				11	10	11	17	19	13	11	14	15
71	7	7	7	7	9	8	8	12	21	19	14			8	8	8	9	10	9	9	9	8	8	7
72	6	5	5	4	2	4	6	9	17	28	20	22		19	6	13	11	9	8	5	6	7	6	6
74	17	14	12	12	11	13	12	13	21	17	10	4				2	3	3	4	6	7	7	7	7
75	21	20	20	19	17	15	16	18	21	15	10	10			5	8	13	13	14	12	12	14	15	14
76	7	6	4	3	5	7	8	10	13	10	11				5	6	7	8	9	8	5	5	5	5
79	15	11	9	10	6	7	9	10	9	6	6	12		5	8	6	5	6	9	13	13	13	13	11
80	9	9	8	7	9	10	11	19	30	37	41	21		10	9	10	12	9	11	11	13	10	9	9
OC1	6	9	8	5		10	8	9	16	20	22	17	12	10	11	6	7	10	11	10	9	8	8	7
OC3	8	7	7	6	6	7	6	10	15	10	14	11	5	3	5	3	5	4	6	7	7	7	7	6

Hour PST (30 September 1969)

Station	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	4	5	5	5	5	3	2	1	7	11	12	8				8	10	8	6	5	6	6	5	6
60	9	9	9	9	8	7	6	8	13	16	11	9			4	4	4	5	7	9	9	8	8	8
69	15	13	13	12	11	10	9	13	25	28	45	50				9	16	20	20	17	16	15	14	15
71	7	7	6	6	6	6	7	12	21	20	24		14	13	7	5	6	4	6	5	5	5	6	6
72	6	5	4	4	4	4	6	13	22			13	15	18	20	16	15	14	10	7	7	6	4	4
74	7	6	5	4	4	4	4	6	17	17	6	3				1	1	3	13	15	14	13	12	11
75	14	13	9	6	5	5	6	13	20	17	9	10				17	15	14	13	16	20	18	15	15
76	5	5	3	4	4	5	5	8	11					23	22	14	14	9	5	5	6	6	6	5
79	9	8	7	6	5	5	6	9	11	9	14	17				5	6	11	14	12	11	11	13	13
80	11	10	10	9	8	7	9	13	21	25	17				27	22	19	13	11	9	7	8	7	5
OC1	7	6	6	5		6	6	9		9	9	7	5	5	7	8	11	11	7	6	5	5	5	5
OC3	8	5	4	4	4	4	4	7	10	13	6	4	5	8	9	6	7	7	7	6	6	7	6	6

*Concentrations in pphm.

Table E-7. NO + NO_2 Concentrations Measured by Los Angeles and Orange County Air Pollution Control Districts on 29 and 30 September 1969*

Hour PST (29 September 1969)

Station	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	10	15	16	15	15	20	18	31	47	49	29	15			7	9	12	13	13	15	16	14	14	20
60	17	20	19	18	18	16	18	17	19	12	9	6				6	8	8	12	16	13	14	14	14
69	32	32	33	37	41	44	46	51	52	43	35	22				12	12	14	29	46	40	42	50	51
71	13	14	11	8	14	16	23	47	59	25	17			9	9	10	12	15	10	14	18	18	21	28
72	9	8	7	5	3	20	33	35	35	38	29	30		35	24	34	32	30	28	9	11	19	22	21
74	29	32	31	23	20	22	20	24	28	18	11	5				3	4	4	5	8	11	14	12	15
75	30	24	24	24	22	20	21	24	25	16	11	11			6	9	15	15	17	19	24	34	42	37
76	12	9	5	4	7	10	25	30	22	16	15				6	8	10	11	14	13	6	6	8	8
79	26	17	12	15	9	9	18	26	11	7	7	13		6	10	7	6	8	14	24	31	30	30	29
80	19	20	19	17	21	30	41	53	39	40	43	22		11	10	11	14	10	12	16	26	26	24	28
OC1	15	15	17	11		19	28	30	23	24	23	17	13	11	12	8	8	12	17	14	16	20	20	19
OC3	10	10	9	9	9	8	16	23	23	10	18	13	6	3	6	5	7	7	10	15	17	23	29	22

Hour PST (30 September 1969)

Station	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	23	32	36	38	40	41	47	52	58	41	22	15				11	14	10	8	8	10	14	20	23
60	14	12	13	13	10	9	10	16	15	17	12	10			5	5	5	6	8	10	10	9	10	10
69	51	51	55	64	68	65	66	72	74	61	63	55				10	18	24	28	26	29	32	35	37
71	32	31	31	29	24	27	60	59	45	27	26		15	14	8	6	7	5	10	17	16	23	30	33
72	15	11	7	7	8	12	38	58	60			21	22	23	23	21	24	24	19	15	15	18	10	15
74	19	20	18	16	12	10	14	25	37	22	7	4				2	2	4	14	20	27	32	27	24
75	33	36	22	15	17	20	29	32	28	20	10	11				18	16	15	14	18	27	30	24	23
76	8	11	4	10	23	40	45	34	18					31	25	18	25	15	7	6	8	12	21	20
79	21	13	10	8	7	10	29	28	14	10	15	18				6	7	12	16	15	15	16	25	28
80	25	19	21	25	22	34	54	40	34	32	19				28	23	20	14	13	12	12	17	15	11
OC1	20	21	22	26		15	27	32		10	9	7	6	6	8	12	12	12	11	9	10	13	9	9
OC3	19	12	12	10	10	12	32	41	20	20	8	4	6	13	11	8	9	10	10	12	10	11	10	9

*Concentrations in pphm.

Table E-8. Nitric Oxide Concentrations Measured by Los Angeles County Air Pollution Control District on 29 and 30 September 1969*

Hour PST (29 September 1969)

Station	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	5	9	10	9	10	16	16	28	36	30	11	5			2	3	5	6	8	11	12	10	11	15
60	4	5	5	5	5	4	6	4	3	1	1	1				1	1	1	1	3	2	3	4	4
69	19	20	21	24	27	29	31	34	27	14	7	3				1	2	3	12	27	27	31	36	36
71	6	7	4	1	5	8	15	35	38	6	3			1	1	2	3	5	1	5	9	10	13	21
72	3	3	2	1	1	16	27	26	18	10	9	8		16	18	21	21	21	20	4	5	12	16	15
74	12	18	19	11	9	9	8	11	7	1	1	1				1	1	1	1	2	4	7	5	8
75	9	4	4	5	5	5	5	6	4	1	1	1			1	1	2	2	3	7	12	20	27	23
76	5	3	1	1	2	3	17	20	9	6	4				1	2	3	3	5	5	1	1	3	3
79	11	6	3	5	3	2	9	16	2	1	1	1		1	2	1	1	2	5	11	18	17	17	18
80	10	11	11	10	12	20	30	34	9	3	2	1		1	1	1	2	1	1	5	13	16	15	19

Hour PST (30 September 1969)

Station	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	19	27	31	33	35	38	45	51	51	30	10	7				3	4	2	2	3	4	8	15	17
60	5	3	4	4	2	2	4	8	2	1	1	1			1	1	1	1	1	1	1	1	2	2
69	36	38	42	52	57	55	57	59	49	33	18	5				1	2	4	8	9	13	17	21	22
71	25	24	25	23	18	21	53	47	24	7	2		1	1	1	1	1	1	4	12	11	18	24	27
72	9	6	3	3	4	8	32	45	38			8	7	5	3	5	9	10	9	8	8	12	6	11
74	12	14	13	12	8	6	10	19	20	5	1	1				1	1	1	1	5	13	19	15	13
75	19	23	13	9	12	15	23	19	8	3	1	1				1	1	1	1	2	7	12	9	8
76	3	6	1	6	19	35	40	26	7					8	3	4	11	6	2	1	2	6	15	15
79	12	5	3	2	2	5	23	19	3	1	1	1				1	1	1	2	3	4	5	12	15
80	14	9	11	16	14	27	45	27	13	7	2				1	1	1	1	2	3	5	9	8	6

*Concentrations in pphm.

Table E-9. Total Hydrocarbon Concentrations (as Methane) Measured by Los Angeles and Orange County Air Pollution Control Districts on 29 and 30 September 1969*

Station	Hour PST (29 September 1969)																							
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	4	4	4	5	6	6	6	8	8	6	5	3	2	2	2	3	3	3	3	2	4	4	4	6
60	7	7	8	8	8	7	7	6	6	6	6	5	6	5	5	4	4	5	5	6	7	8	8	8
79	4	4	3	4	3	2	3	3	3	2	3	3	3		2	1	1	1	2	3	4	4	4	5
OC1	5	8	6	5	7	8	7	7	7	7	6	6	6	4	4	3	3	4	4	4	5	4	4	4

Station	Hour PST (30 September 1969)																							
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	6	8			9	8	10	9				4	3	2	2	2	2	2	2	2	2	3	4	4
60	8	10	11	10	8	9	8	7	6	5	5	5	6	6	4	5	4	5	6	8	9	8	7	9
79	5	4	3	3	3	4	5	5	3	3	3	4	5	3	2	2	2	2	3	3	3	3	4	5
OC1	6	6	7	8	8	9	13	6	4	4	3	3	3	3	3	3	4	3	3	3	3	3	3	4

*Concentrations in ppm.

Table E-10. Methane Concentrations Measured by Los Angeles County Air Pollution Control District on 29 and 30 September 1969*

Station	Hour PST (29 September 1969)																							
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	3	4	4	4	5	5	5	6	6	5	4	3	2	2	2	3	2	2	3	2	3	3	3	4
60	4	4	5	6	5	4	5	4	3	3	3	3	3	3	2	2	2	2	2	2	3	4	4	4
79	3	3	3	3	2	2	2	2	2	2	2	3	2		2	1	1	1	2	2	3	3	3	3

Station	Hour PST (30 September 1969)																							
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	4	5			9	6	6	6				4	3	2	2	2	2	2	2	2	2	2	3	3
60	4	6	6	6	4	5	5	3	4	3	3	3	3	3	2	2	2	2	2	4	5	4	4	4
79	3	3	3	3	3	3	4	3	3	3	3	3	4	2	2	2	2	2	2	2	2	2	3	4

*Concentrations in ppm.

Table E-11. Parameter Coding Index Used in Tables E-12 and E-13*

OXA - Total oxidant (Acralyzer), pphm

OX - Total oxidant (Mast), pphm

OXR - Residual oxidant, pphm

O3 - Ozone, pphm

NOM - Nitric oxide (manual), pphm

NO - Nitric oxide (Acralyzer), pphm

NO2M - Nitrogen dioxide (manual), pphm

NO2 - Nitrogen dioxide (Acralyzer), pphm

HC - Total hydrocarbons (as methane), ppm

CO - Carbon monoxide, ppm

* See Section I, Part B for measurement techniques used.

Table E-12. Summary of Contaminant Concentrations Measured by Scott Research at El Monte on 29 and 30 September 1969*

Contaminant	Hour PST (29 September 1969)																							
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
OX**	0	0	0	0	1	1	1	1	2	7	15	25	27	16	11	6	4	2	4	2	3	1	0	0
OXR	0	0	0	0	1	1	1	1	2	1	2	3	3	2	1	1	3	2	2	2	3	1	0	0
O3	0	0	0	0	0	0	0	0	1	6	13	22	23	14	7	5	2	0	2	0	0	0	0	0
NOM									7	5	3	3	2	2	1	1	1							
NO2M									22	23	17	18	13	8	8	8	8							
HC	4								6	5	5	6	5	3	3	3	3	4	4					
CO									8	6	6	9	5	3	2	2		4	5	3				

Contaminant	Hour PST (30 September 1969)																							
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
OX	0	0	0	0	0	0	1	2	2	4	7	10	14	17	13	11	7	3	1	1	1	1	1	0
OXR	0	0	0	0	0	0	1	1	1	2	1	2	1	1	3	1	1	1	1	1	1	1	1	0
O3	0	0	0	0	0	0	0	0	0	4	6	9	13	16	11	9	6	2	0	0	0	0	0	0
NOM								4	22	8	3	2	2	2	1	2	1	2						
NO2M								3	33	26	17	12	12	11	8	7	9	13						
HC									7	6	5	4	4	4	2	2	3	3	3	3	3	5	6	7
CO								11	13	5	3	2	2	3	2	2	2	4	3					

*See Section I, Part C for a description of the derivation of this table.

**See Table E-11 for parameter coding index.

Table E-13. Summary of Contaminant Concentrations Measured by Scott Research at Commerce on 29 and 30 September 1969*

Contaminant	Hour PST (29 September 1969)																							
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
OXA**	1	1	1	1	2	2	2	3	7	11	17	21	14	11	9	6	2	3	2	1	1	1	1	0
OX	2	2	2	2	2	3	3	3	5	5	9	12	8	5	5	4	3	4	3	2	2	2	2	2
OXR	2	2	2	2	2	3	3	3	5	5		3	3	3	3	3	3	4	3	2	2	2	2	2
O3	0	0	0	0	0	0	0	0	0	0		9	5	2	2	0	0	1	0	0	0	0	0	0
NOM						40	41	48	25	9	6	7	2											
NO	11	14	14	13	21	23	26	32	22	15	7	6	3	9	6	9					1	5	9	8
NO2M						11	12	16	32	38	30	13	10											
NO2	7	7	8	7	10	11	10	16	26	32	25	14	10	9	7	7	4	3	5	4	3	3	3	
HC	3	4	5	4	5	7	8	10	7	9	6	4	3	3	3	3	3	2	3	3	3	4	6	7
CO	7	7	7	7	10	9	12	17	15	15	9	6	4	3	3	4	3	3	3	3	5	6	6	7

Contaminant	Hour PST (30 September 1969)																							
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
OXA	1	2	2	2	2	2	2	3	3	5	6	13	19	17	12	5	4	4	1	1	0	0	0	
OX	2	2	2	2	2	2	3	4	4	4	4	9	15	13	9	5	4	4	2	2	2	2	2	2
OXR	2	2	2	2	2	2	3	4	4	4	4	3	3	3	3	3	3	3	2	2	2	2	2	2
O3	0	0	0	0	0	0	0	0	0	0	0	5	12	10	6	2	2	1	0	0	0	0	0	0
NOM							70	37	20	11	8													
NO	17	23	22	28	29	35	38	31	17	10	5	2	1	0	1	4	4	2	0	0	7	12	13	14
NO2M						11	12	17	30	27	26													
NO2	5	4	5	6	6	6	8	12	16	18	17	14	11	6	3	4	3	3	2	1	3	3	3	1
HC	8	9	8	12	11	12	13	12	8	6	5	5	5	3	2	2	2	2	2	3	3	4	5	4
CO	11	10	10	12	14	17	22	17	11	8	7	6	6	3	3	3	3	2	2	2	6	6	7	6

*See Section I, Part C for a description of the derivation of this table.

**See Table E-11 for parameter coding index.

Table E-14. Peak Indexing and Reactivity Classification of Atmospheric Hydrocarbons Observed in Chromatograph Analysis Carried Out by Scott Research

Reactivity Classification	Peak Number	Compound	Reactivity Classification	Peak Number	Compound
U*	1	Methane	U	35	Benzene + Cyclohexane
U	2	Ethane	U	36	2-Methylhexane +
R	3	Ethylene			2,3-Dimethylpentane
U	4	Propane	U	37	3-Methylhexane
R	5	Propylene	U	41	2,2,4-Trimethylpentane
U	6	Acetylene	R	42	1-Heptene + ?
U	7	Isobutane	U	43	n-Heptane
U	8	Butane	U	46	Methylcyclohexane
R	9	Butenes	U	49	2,4-Dimethylhexane
U	10	Isopentane	U	50	2,5-Dimethylhexane
R	11	1-Pentene +	U	54	2,3,4-Trimethylpentane
		2-Methyl-1-butene	R	55	Toluene
U	12	n-Pentane	U	62	n-Octane
R	13	trans-2-Pentene	R	70	Ethylbenzene
R	14	cis-2-Pentene	R	73	m + p-Xylene
R	15	2-Methyl-2-butene	R	77	o-Xylene
U	16	2,2-Dimethylbutane	U	80	n-Nonane
R	19	Cyclopentene	R	83	Isopropylbenzene
U	20	Cyclopentane	R	89	n-Propylbenzene
U	21	2,3-Dimethylbutane	R	90	4-Ethyltoluene
U	22	2-Methylpentane	R	91	3-Ethyltoluene
U	23	3-Methylpentane	R	93	1,3,5-Trimethylbenzene
R	24	1-Hexene	R	94	2-Ethyltoluene
U	25	n-Hexane	R	96	tert-Butylbenzene
R	26	trans-3-Hexene	R	97	1,2,4-Trimethylbenzene
R	27	trans-2-Hexene	U	99	n-Decane
R	28	cis-3-Hexene	R	100	sec-Butylbenzene
R	29	cis-2-Hexene	R	101	Isobutylbenzene
U	30	Methylcyclopentane	R	108	n-Butylbenzene
U	31	2,4-Dimethylpentane	U	114	n-Undecane

*U--Unreactive; R--Reactive

Table E-15. Example of Hydrocarbon Analysis Made by Scott Research at El Monte, 29 September 1969 at 0925 PST

Peak*	PPB	Peak	PPB	Peak	PPB	Peak	PPB	Peak	PPB	Peak	PPB
1	2808.00	21	0.00	41	0.60	61	3.69	81	0.00	101	0.00
2	82.85	22	3.56	42	0.00	62	4.12	82	0.00	102	0.00
3	64.28	23	2.52	43	1.37	63	0.00	83	2.88	103	0.00
4	36.41	24	0.00	44	0.00	64	0.00	84	0.00	104	0.00
5	20.81	25	8.22	45	0.00	65	0.00	85	0.00	105	0.00
6	43.86	26	0.00	46	0.00	66	0.00	86	0.00	106	0.00
7	16.48	27	0.00	47	0.00	67	0.00	87	0.00	107	0.00
8	50.94	28	0.00	48	0.00	68	0.00	88	0.00	108	0.00
9	0.00	29	0.00	49	0.00	69	0.00	89	0.00	109	0.00
10	16.53	30	2.16	50	0.00	70	4.00	90	6.59	110	0.00
11	0.00	31	0.00	51	0.00	71	0.00	91	0.00	111	0.00
12	7.14	32	0.00	52	0.00	72	0.00	92	0.00	112	0.00
13	0.00	33	0.00	53	0.00	73	16.24	93	12.73	113	0.17
14	0.00	34	0.00	54	1.12	74	0.00	94	0.00	114	0.00
15	0.00	35	5.34	55	27.94	75	0.00	95	14.34	115	2.85
16	0.00	36	2.43	56	0.00	76	0.00	96	0.00	116	0.00
17	0.00	37	1.44	57	0.00	77	7.93	97	0.00	117	0.00
18	0.00	38	0.00	58	0.00	78	0.00	98	0.00	118	0.00
19	0.00	39	0.00	59	0.00	79	3.54	99	14.44	119	0.00
20	0.00	40	0.00	60	0.00	80	0.00	100	0.00	120	0.00

TOTAL CONCENTRATION 3297.51

*See Table E-14

In accordance with the restricted application of these data, we limit the discussion of this section to a brief description of the means whereby the airborne data were obtained. Reference should be made to the Scott study cited earlier for a complete description of the methods used for data collection and reduction and for a presentation of the data.

The airborne data were collected by two methods: helicopter and aircraft. Section A describes the procedure whereby data were collected with the aid of aircraft and Section B describes the helicopter program.

A. Aircraft Data Collection Program

During the period August 18 to November 19, 1969 the Scott Research Laboratories flew 26 aircraft flights over the Los Angeles Basin in order to make measurements of chemical and meteorological variables in the atmosphere. Two flights were made on both the 29 and 30 September, commencing at about 7:30 a.m. and noon PST each day. These flights originated and terminated at El Monte Airport and had a duration of approximately 1 1/2 hours. The flight plan, which is illustrated in Figure E-2, is described in detail in the Scott report beginning on page 3-2 of Volume I.

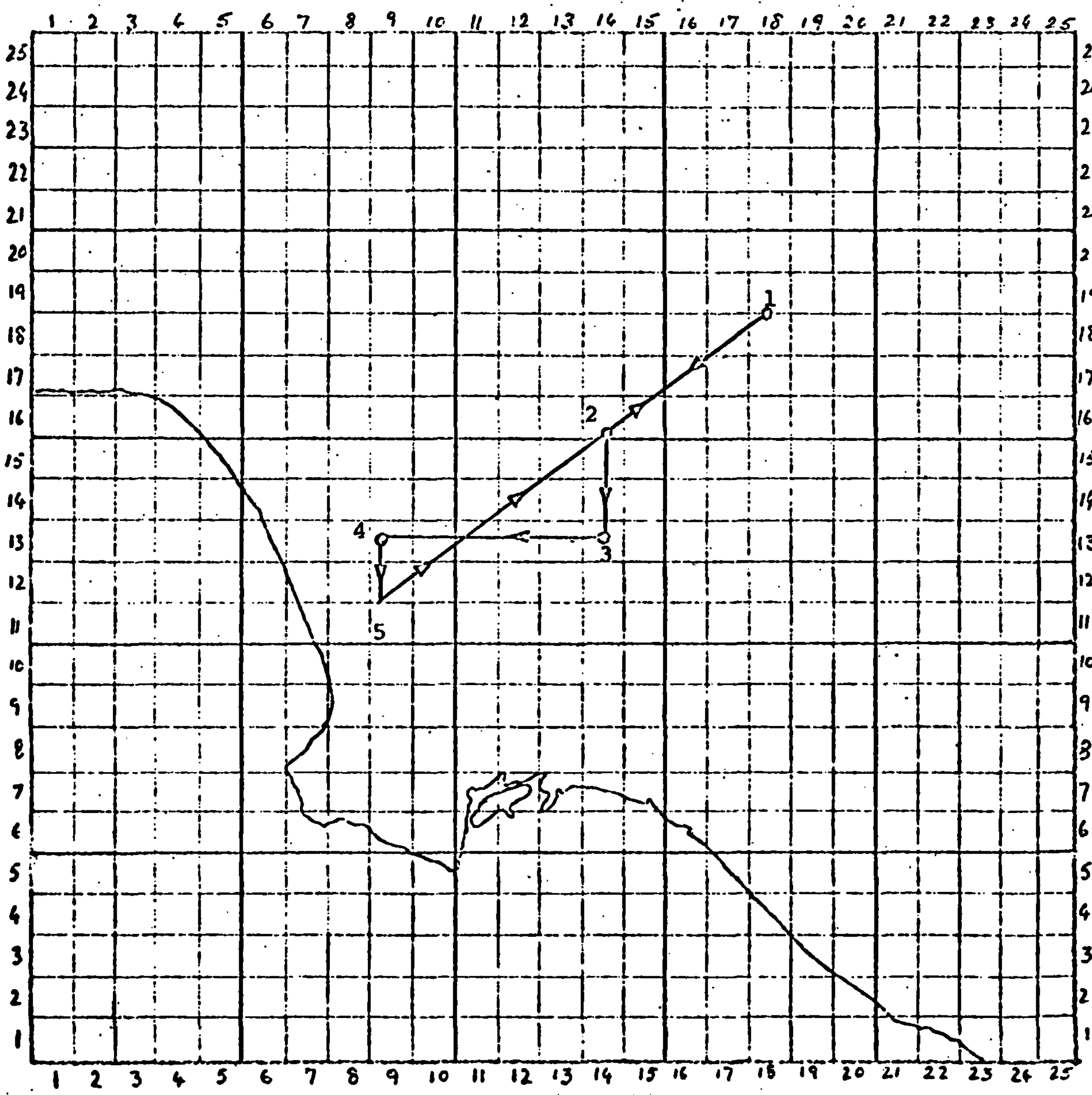
During the course of all flights, air temperature, relative humidity, oxidant concentration, and incoming and outgoing ultraviolet irradiation were continuously measured and recorded. These parameters are reported at 10-second intervals for the duration of each flight. In addition, a number of Tedlar bag air samples were taken when the aircraft was in level flight. The contents of the bags were analyzed later to determine the concentrations of the individual C_1 to C_{10} hydrocarbons, NO, NO_2 and CO.

B. Tetroon and Helicopter Data Collection Program

An ESSA research program to map air trajectories was conducted during September and early October 1969 as part of a study of air quality in the Los Angeles Basin. Tetroons (free balloons) were released from various sites in the basin, their paths being tracked by ground-based radar. In addition, their trajectories were followed by a helicopter equipped to collect air samples in Tedlar bags in the vicinity of the tetroons. These samples were analyzed in the same manner as those collected by aircraft. See Scott Research (1970) for a complete listing of sample analyses.

Five helicopter flights were flown on the days of the 29 and 30 September. In order to compare the helicopter and tetroon trajectories for these days, it is necessary to refer to the descriptions of tetroon flights in Pack, et al. (1970) and the descriptions of helicopter flights in Scott Research (1970). Several flight paths have been plotted in Eschenroeder and Martinez (1970) showing the helicopter and tetroon trajectories simultaneously. One of the plots shown is for a 29 September flight, one of our validation days.

Figure E-2 follows



1. El Monte Airport
2. Commerce
3. Intersection of Los Angeles and Rio Hondo Rivers
4. Hawthorne Airport
5. Alondra Park

Spiral ascents and/or descents to collect data were made over El Monte, Commerce and Alondra Park.

Figure E-2. Aircraft Flight Plan

References

Altshuller, A. P., "Analysis of Organic Gaseous Pollutants," in Air Pollution, (A. Stern, Ed.) Vol. II, Academic Press, 2nd Edition (1968).

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