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ANALYSIS OF ORGANIC AIR POLLUTANTS BY GAS CHROMATOGRAPHY AND MASS SPECTROSCOPY



**Environmental Sciences Research Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina 27711**

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ANALYSIS OF ORGANIC AIR POLLUTANTS BY
GAS CHROMATOGRAPHY AND MASS SPECTROSCOPY

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ABSTRACT

Analytical methodology based on capillary gas chromatography/mass spectrometry/computer was developed for the collection and analysis of urban organic pollutants. The areas of investigation included: (a) the preparation and evaluation of glass capillary columns for pollution analysis, (b) the development of methodology for quantitative analysis of ambient air pollutants, and (c) the identification and quantification of organic pollutants in ambient air from several geographical locations within the continental U.S.

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SECTION 1

INTRODUCTION

In order to ascertain whether a health-effect problem exists due to exposure to hazardous organic gases and vapors, pollutants in ambient air should be characterized and the identified chemicals quantified. In contrast to research on criteria pollutants and particulates, investigations surrounding the volatile organics has been meager. It is suspected that the major mass of organic material in ambient air is composed of organic gases and vapors. This observation is not surprising in view of the emission rates from fossil fuel consumption for energy and chemical syntheses.

Preliminary research at the Research Triangle Institute has revealed that hazardous substances in fact do occur in the ambient air. Nitrosamines and halogenated compounds have been identified, many of which are suspected mutagens and carcinogens. The major effort in the past has been associated with the characterization of halogen, oxygen, and nitrogen containing substances; however, the existence of hazardous sulfur materials are also suspected.

The main thrust of this program has been to adapt and perfect methodology⁽¹⁻⁴⁾ for quantitative analysis of atmospheric pollutants by gas chromatography/mass spectrometry/computer (gc-ms-comp). This report presents techniques which were developed and integrated as a total method for obtaining qualitative and quantitative information on organic vapors in ambient air. Results obtained during characterization and quantification of pollutants surrounding industrial activity are also discussed.

SECTION 2

CONCLUSIONS

The preparation and evaluation of glass capillary columns for the analysis of ambient air pollutants was performed. The four criteria of efficiency, resolution, peak symmetry and capacity were used for evaluating glass SCOT capillaries coated with OV-101, OV-17, Dexil 300 and OV-225. The four criteria indicated a superior performance could be obtained for glass capillaries over the stainless steel SCOT's. Their evaluation also indicated that complete resolution of a mixture by any one specific stationary phase for the ambient air pollutants can not be achieved on SCOT's and it was concluded that 2-3 different types of stationary phases will be necessary for analyzing non-polar, semi-polar and polar ambient air pollutants.

Methods for quantitative analysis of ambient air pollutants were also examined. Determination of breakthrough volumes for various chemical classes of organic compounds on Tenax GC was studied. The chemical classes examined were acids, alcohols, aldehydes, amines, aromatics, esters, ethers, halogenated ethers and hydrocarbons, hydrocarbons, inorganic gases, ketones, nitrogen and sulfur-containing compounds. It was concluded that for highly volatile compounds, the breakthrough volumes were too small on Tenax GC and a backup sorbent was necessary. Examination of an SKC carbon indicated that the breakthrough volume for highly volatile materials could be increased by 1-2 orders of magnitude. The use of chemically bonded phases on silica indicated that the breakthrough volumes were comparable to Tenax GC and that these materials were not suitable as backups to Tenax. In the pursuit of a method for the quantification of organic vapors in ambient air, it was concluded several criteria must be addressed. In addition to the breakthrough volume, it was necessary to determine the relative molar response ratios for several organics undergoing glc/ms/comp analysis. The concept of relative molar response ratio (RMR) was delineated and the RMR's for several

compounds based on the total ion current and selected single ions (m/e) as obtained by glc/ms/comp were measured. It was concluded that the relative molar response ratios vary significantly with the type of and substitution frequency of heteroatoms in a molecule. The overall sensitivity of high resolution glc/ms/comp for the analysis of ambient air pollutants was estimated based on the breakthrough volumes and the relative molar response ratios for several organic molecules. The results indicate that parts-per-trillion to sub-parts-per-trillion sensitivity can be achieved for their detection. However, 10-50 times this amount is required for quantification.

The characterization and quantification of ambient air pollutants in the Baltimore area revealed the presence, in addition to N-nitrosodimethylamine, of halogenated hydrocarbons. These were: 1-chloro-2-methylpropene, 3-chloro-3-methylpropene, 2,3-dichlorobutane (meso) and 2,3-dichlorobutane (one of the racemic pairs). The concentration of 1-chloro-2-methylpropene reached a level of 670,000 ng/m³ at a location on an industrial site in Baltimore, MD. The results obtained for the characterization and quantification of ambient air pollutants from Baltimore, MD, Kanawha Valley, WV, New Jersey and Los Angeles, CA Basin areas indicated that the technique of high resolution glc/ms/comp is a viable method of analysis. The method is capable of characterizing and quantifying oxygen, sulfur and nitrogen containing compounds as well as halogenated hydrocarbons and aromatics in the ambient air.

SECTION 3

RECOMMENDATIONS

Six major phases of research should be expanded and pursued: (1) a system should be developed for urban air component separation which will enable the identification and quantification of component mixtures of ambient air pollutants collected at various geographical areas; (2) qualitative identifications and quantitative estimation should be made of pollutant compositions from various environments such as the chemical industry, the products of photochemical reactions, and vehicular exhaust; (3) the sensitivity, accuracy, and reproducibility of the overall analysis systems for several classes of pollutant candidates should be further evaluated; (4) a system for quantitative analysis of atmospheric organic vapors should be developed concurrently with the qualitative identification of those components occurring in automobile exhaust samples using the techniques of gc/ms/comp; (5) organic chemical pollution profiles for the urban environments examined should be delineated into those pollutants unique to particular environment as contrasted to those pollutants commonly found as a general pollutant throughout all urban environments in order that the biological effects can be assessed, and (6) the hazardous organic vapor pollutants in atmospheres which constitutes an immediate crisis situation such as accidents occurring at industrial sites should be examined utilizing these techniques in order to access whether a health problem exists.

SECTION 4

PROGRAM OBJECTIVES

The main emphasis of this research program was to collect urban air organic pollutants for complete characterization and quantification at the parts-per-trillion level. The specific objectives were: (1) to formulate a sample collection system of sufficient efficiency to permit as a minimum the analysis of pollutants present at the low ng/m^3 concentrations; (2) to develop highly efficient glass capillary columns for the resolution of urban air pollutants with emphasis on the elution of polar and semi-polar compounds; (3) to demonstrate the overall sensitivity of the system for several classes of potential pollutant candidates and to acquire quantitative information on these substances and (4) to analyze ambient air pollutants by the use of gas chromatography in tandem with mass spectrometry and provide quantitative analysis for atmospheric organic vapors, concurrently with the qualitative identification. Studies of automobile exhaust composition which contributes to the atmospheric organic vapors were to be performed by gc/ms/comp using the techniques previously developed for ambient air pollutants. In essence, vehicle emissions from prototype vehicles were examined.

SECTION 5
PREPARATION AND EVALUATION OF GLASS CAPILLARY COLUMNS
FOR POLLUTION ANALYSIS

The complexity of the pollutants in ambient air requires the use of high resolution in order to effectively separate the constituents for identification and quantification of compounds of interest.^(1,2) Because these compounds are highly volatile, their analyses precludes the use of chemical purification methods since they would escape during processing. Thus, a requirement for very high resolution gas chromatography exists in order to achieve adequate resolution of these complex mixtures. The obvious approach to this problem is to utilize glass capillary columns coated with appropriate phases which will achieve adequate resolution for various chemical classes of interest. Although there are over 100 stationary phases available for gas-liquid chromatography, only a few of these effectively provide significant differences in resolution. In general it can be stated that stationary phases representative of non-polar, semi-polar and polar types will effectively produce optimum differences in the resolution patterns.

This section discusses the preparation and evaluation of glass capillary columns for the analysis of ambient air pollutants. It examines various stationary phases with regard to definitive evaluation criteria and the selection of phases which may be used for resolving, characterizing and quantifying complex mixtures of ambient air pollutants.

EXPERIMENTAL

Glass support coated open tubular (SCOT) capillaries were prepared according to a previously described procedure.⁽³⁾ SCOT capillaries containing the stationary phases OV-101, OV-17, Dexil 300, Poly I-110 and OV-225 were examined (Table 1).

Four criteria were used for evaluating SCOTS. These were: (1) efficiency, which was determined in terms of the height equivalent to a theoretical plate

Table 1. GLASS SCOT CAPILLARIES TESTED FOR
RESOLVING AMBIENT AIR POLLUTANTS

Stationary Phase	Surfactant ^a	Percent Phase Used	length m	i.d. (mm)
Carbowax 20M	BTPPC1/0.1%	0.96	38	0.35
OV-17	BTPPC1/0.1%	1.0	60	0.27
OV-225	BTPPC1/0.1%	1.0	104	0.27
Poly I-110	BTPPC1/0.1%	1.0	90	0.27
Dexil 300 GC ¹	BTPPC1/0.1%	2.5	106	0.31

^aBenzyltriphenyl phosphonium chloride

$$\text{HETP} = \frac{L}{5.54 \left(\frac{RT}{W_{1/2}} \right)^2}$$

L = length of column

RT = retention time (min)

$W_{1/2}$ = width of peak at half height (min)

(2) resolution, which was determined for three isomeric pairs, 4-methylpentene-1 vs 2-methylpentene-1; 1-chloro-2-methylpropene vs 3-chloro-2-methylpropene and p-xylene vs m-xylene

$$R = \frac{2 \Delta T_r}{W_1 + W_2}$$

ΔT_r = difference in retention between peaks 1 and 2
 W_n = peak width at its base

(3) symmetry, which was determined for each peak as a percent ratio of the area of the front portion of the peak to the back portion. The peak was divided for this purpose by a line drawn perpendicular from the peak maxima to the baseline. Areas were measured with a planimeter.

$$\% S = \frac{f}{b} \times 100$$

f = area of front peak-half

b = area of back peak-half

and (4) capacity, which was evaluated by applying the above criteria to objections of a test mixture at three different concentrations which spanned a range of two orders of magnitude.

RESULTS AND DISCUSSION

The test mixture used for evaluating SCOT capillaries is summarized in Table 2. The components selected provided a representative range of polarities. They are compounds which have been previously identified in ambient air. Three isomeric pairs are included for comparison of the resolution obtained on the different capillary columns. These results are summarized in Table 3. None of the columns prepared and tested proved capable of completely resolving all isomers. Resolution of the olefins and chloro-olefin isomeric pairs varied considerable with the polarity of the

Table 2. TEST MIXTURE FOR EVALUATING GLASS
CAPILLARY COLUMNS

Compound	Relative Quantities ^a (μg/ml)
4-Methylpentene-1	1.5 (0.49)
2-Methylpentene-1	1.5 (0.50)
1-Chloro-2-methylpropene	2.0 (0.92)
3-Chloro-2-methylpropene	2.0 (0.91)
Ethyl acetate	3.0 (1.35)
2-Butanone	3.0 (1.20)
Toluene	1.0 (0.43)
N,N-Dimethylformamide	3.0 (1.42)
Tetrachloroethylene	2.0 (1.60)
p-Xylene	1.0 (0.43)
m-Xylene	1.0 (0.43)
Acetophenone	3.0 (1.54)
Nitrobenzene	3.0 (1.80)
n-Undecane	1.0 (0.37)

^aRelative volumes used, concentration in parenthesis.

Table 3. PERFORMANCE OF SELECTED GLASS CAPILLARY COLUMNS

Column	Criteria	4-methylpentene-1	2-methylpentene-1	1-chloro-2-methylpropene	3-chloro-2-methylpropene	ethyl acetate	2-butanone	toluene	tetrachloroethylene	N,N-dimethylformamide	p-xylene	m-xylene	acetophenone	nitrobenzene	n-undecane
200 ft SS SCOT OV-17	100 ng														
	HETP							0.99							
	T _R	0.56	0.61	0.63	0.65	0.75	0.75	1.0	1.11	1.12	1.28	1.28	1.94	1.94	1.86
	PS	42	42	47	47	a	a	25	36	32	28 ^b	28 ^b	a	a	
	R	3.22		0.54							0				
	1000 ng														
	T _R	0.51	0.57	0.62	0.64	0.69	0.69	1.0	1.11	1.13	1.28	1.28	1.87	1.87	1.90
	PS	37	37	38	38	a	a	31	b	24	22 ^b	22 ^b	a	a	54
	R	4.40		0.50							0				
	5000 ng														
	T _R	0.50	0.56	0.61	0.63	a	a	1.0	1.11	1.11	1.29	1.29	1.89	1.89	1.89
	PS	40	40	11	11			14	15	15	19 ^b	19 ^b	a	a	19
	R	4.00		0.40							0				
	10,000 ng														
	T _R	0.51	0.56	0.61	0.63	0.60	0.60	1.0	1.12	1.12	1.29	1.29	1.91	1.91	1.91
	PS	20	20	13	13	a	a	12	15	15	8 ^b	8 ^b	a	a	32
	R	4.00		0.39							0				

(continued)

Table 3 (cont'd)

Column	Criteria	4-methylpentene-1	2-methylpentene-1	1-chloro-2-methylpropene	3-chloro-2-methylpropene	ethyl acetate	2-butanone	toluene	tetrachloroethylene	N,N-dimethylformamide	p-xylene	m-xylene	acetophenone	nitrobenzene	n-undecane
105 m GSCOT OV-101	100 ng														
	T _R	0.52	0.57	0.64	0.66	a	a	1.0	1.11	1.11	1.24	1.25	1.70	1.71	1.74
	PS	67	67	52	52			53	83	83	52	52	53	51	100
	R	4.10		0.52							0				
	1000 ng														
	T _R	0.52	0.59	0.64	0.66	a	a	1.0	1.11	1.11	1.25	1.25	1.68	1.71	1.74
	PS	57	57	57	57			53	87	87	64 ^b	64 ^b	83	85	101
	R	4.20		0.45							0				
	10,000 ng														
	T _R	0.52	0.58	0.64	0.65	0.61	0.61	1.0	1.16	1.16	1.25	1.25	1.67	1.72	1.76
	PS	54	54	33	33	a	a	50	55 ^b	55 ^b	62 ^b	62 ^b	23	46	179
	R	4.40		0.40							0				
95 m GSCOT (silanized) OV-101	100 ng														
	T _R	0.53	0.60	0.65	0.66	a	a	1.0	1.10	1.10	1.23	1.23	1.73	1.73	1.73
	PS	85	100	100	77			51	50 ^b	50 ^b	81 ^b	81 ^b	54 ^b	54 ^b	54 ^c
	R	2.87	0.40								0				
	1000 ng														
	T _R	0.53	0.59	0.65	0.66	a	a	1.0	1.10	1.10	1.24	1.24	1.71	1.71	1.73
	PS	65	86	98	98			58	61 ^b	61 ^b	72 ^b	72 ^b	166 ^b	166 ^b	42
	R	2.77	0.39								0				

(continued)

Table 3 (cont'd)

Column	Criteria	4-methylpentene-1	2-methylpentene-1	1-chloro-2-methylpropene	3-chloro-2-methylpropene	ethyl acetate	2-butanone	toluene	tetrachloroethylene	N,N-dimethylformamide	p-xylene	m-xylene	acetophenone	nitrobenzene	n-undecane
12	10,000 ng														
	T _R	0.53	0.60	0.64	0.65	0.62	0.62	1.0	1.11	1.11	1.24	1.24	1.67	1.71	1.74
	PS	68	78	60		a	a	61	66 ^c	66 ^c	62 ^c	62	44	62	94
	R	2.88		0.25							0				
	60 m GSCOT														
	OV-17														
	100 ng														
	HETP														
	T _R	0.41	0.45	0.56	0.61	a	a	1.61	1.08	1.08	1.32	1.32	2.29	2.29	2.18
	PS	54	56	64	64			53	56 ^b	56 ^b	71 ^b	71 ^b	84	b	58
	R	1.10		0.47							0				
	1000 ng														
	T _R	0.40	0.46	0.57	0.61	a	a	1.0	1.09	1.09	1.32	1.32	2.28	2.28	2.18
	PS	46	64	46	47			48	59 ^b	59 ^b	64 ^b	64 ^b	56 ^b	56 ^b	68
	R	0.60		0.52							0				
	10,000 ng														
	T _R	0.40	0.45	0.57	0.62	a	a	1.0	1.09	1.09	1.32	1.32	2.28	2.28	2.17
	PS	26	28	53	66			56	75 ^b	75 ^b	75 ^b	75 ^b	85 ^b	85 ^b	66
	R	0.59		0.51							0				
	106 m GSCOT														
	(silanized)														
	Dexisil														
	1000 ng														
	T _R	0.49	0.55	0.64	0.65	0.67	0.67	1.0	1.09	1.09	1.26	1.81	1.81	1.89	1.68
	PS	58	75	b	b	a	a	71	71 ^b	71 ^b	64 ^b	64 ^b	35 ^b	74	84
	R	2.00		0.23							0				

(continued)

Table 3 (cont'd)

Column	Criteria	4-methylpentene-1	2-methylpentene-1	1-chloro-2-methylpropene	3-chloro-2-methylpropene	ethyl acetate	2-butanone	toluene	tetrachloroethylene	N,N-dimethylformamide	p-xylene	m-xylene	acetophenone	nitrobenzene	n-undecane
13	10,000 ng														
	Tr	0.46	0.51	0.61	0.62	0.59	0.59	1.0	1.10	1.10	1.30	1.30	1.95	2.06	1.82
	PS	80	83	a	a	a	a	66	83 ^b	83 ^b	68 ^b	68 ^b	84	89	107
	R	1.96		0.15							0				
	104 m GSCOT														
	OV-225														
	100 ng														
	HETP														
	Tr	0.32	0.32	0.37	0.41	0.43	0.45	1.0	0.77	0.80	1.45	1.45	1.92	2.06	1.68
	PS	43 ^b	43 ^b	36	52	a	a	51	70	56	73 ^b	73 ^b	54	84	47
	R	0		2.19							0				
13	1000 ng														
	Tr	0.27	0.29	0.40	0.45	0.48	0.56	1.0	0.73	0.76	1.45	1.45	1.98	2.12	1.69
	PS	60	89	54	48	51	59	54	b	53	64 ^b	64 ^b	82	53	83
	R	1.23		0.94							0				
	10,000 ng														
	Tr	0.29	0.31	0.43	0.50	0.53	0.60	1.0	0.77	0.80	1.43	1.43	1.65	2.04	1.90
	PS	53	70	54	61	62	53	71	57	32	61 ^b	61 ^b	67	55	73
	R	1.84		3.73							0				

^aComponents were unresolved, PS not determined.^bPeak symmetry was determined on unresolved components.

stationary phase. None of the columns evaluated showed extremely high efficiency as measured in terms of height equivalent to a theoretical plate, however their resolution was good. Peak symmetry was near ideal on glass capillaries whereas, back tailing was clearly evident during chromatography on stainless steel capillaries.

Using the test criteria HETP, separation efficiencies, peak symmetry, and the relationship between the elution order for a standard mixture, it was possible to assess in a quantitative fashion the utility of these glass capillaries for resolving ambient air pollutants. Ideally, the selection of 2-3 glass capillaries would be preferred for the resolution of ambient air pollutants so that the identification of constituents and their quantification can be made.

SECTION 6

DEVELOPMENT OF METHODOLOGY FOR QUANTITATIVE ANALYSIS OF AMBIENT AIR POLLUTANTS

This chapter addresses a conceptual approach for obtaining quantitative information on the atmospheric pollutants which are identified in ambient air samples collected on Tenax GC. It also addresses the limitations of the sorbent Tenax GC and examines alternate sources of backup materials for collecting pollutants which are not efficiently trapped on Tenax GC.

The requirements for obtaining quantitative data with regard to the performance of the Tenax GC sorbent and the methodology for the calibration of instrumentation are described. This chapter presents studies on the various parameters which are deemed necessary for obtaining quantitative information concerning atmospheric pollutants. The subject of breakthrough volumes of various chemical classes on Tenax GC, the examination of an alternate backup sorbent and the concept of relative molar response ratios are all addressed in this chapter.

THE DETERMINATION OF BREAKTHROUGH VOLUMES FOR VARIOUS CHEMICAL CLASSES OF ORGANIC COMPOUNDS ON TENAX GC

The purpose of this study was to determine the breakthrough volumes for several organic vapors which have either been identified or are anticipated to be present in ambient air. Furthermore, the objectives were to examine several compounds within various chemical classes in order to determine whether an empirical relationship exists between a homologous series and to what extent it may be possible to predict the breakthrough volumes for compounds of similar structural types. With an empirical approach such as this, the ability to predict the breakthrough will greatly facilitate the ability to obtain quantitative information about the levels of atmospheric pollutants.

Experimental

Breakthrough volumes were estimated for a number of organic vapors which had been previously identified or anticipated to be present in ambient air.⁽⁴⁾ The method employed consisted of determining the elution volume for an organic vapor on a gas chromatographic column packed with a sorbent Tenax GC. The column with the dimension of 3 mm x 1.76 m in length was used. After injecting each vapor, the elution volume was determined as the product of flow rate and elution time. A series of injections were made at decreasing temperatures and a plot of the $\log 1/v_e$ vs temperature was constructed. Using a linear regression analysis, the breakthrough volumes (50% loss) for several ambient temperatures were determined by extrapolation. At the end of the experiment, the Tenax GC sorbent in the chromatographic column was weighed and the breakthrough volume was expressed in $\ell/2.2$ g which is the standard quantity which has been employed in field sampling.

The technique for determining breakthrough volumes has been previously described and compared with other techniques which has established this method as a viable rapid approach for the determination of breakthrough volumes.^(1,2,4)

Results and Discussion

The breakthrough volumes of acids, alcohols, aldehydes, amines, aromatics, esters, halogenated hydrocarbons, hydrocarbons, inorganic gases, ketones, nitrosoamines, nitrogenous hydrocarbons, oxygenated hydrocarbons and sulfur compounds are given in Table 4. The breakthrough volumes for the more volatile organics such as the aldehydes (e.g. acetaldehyde) and alcohols are relatively low. Generally, the sorbent Tenax GC is not regarded to be an adequate material for the collection of these substances with any degree of reliability or sensitivity. The low molecular amines such as dimethylamine also have low breakthrough volumes.

Examination of the breakthrough volumes for aromatic compounds indicates that the incorporation of an aromatic moiety into a molecule greatly increases the affinity of Tenax GC for the organic vapor. For example, the breakthrough volume for diphenyl vs benzene is increased by almost three orders of magnitude.

Another important relationship which can be extracted from the information presented in this table is the relationship between the breakthrough

volumes at two different temperatures. The slope of the linear regressions are parallel for the compounds within a given chemical class. Therefore, if the breakthrough volume at one temperature is known, then the breakthrough at the remaining temperatures for that unknown can be calculated since the relationship is predictable.

The comparison of isobutylamine and t-butylamine breakthrough volumes reveal that although the boiling of t-butylamine is higher, it had a significantly lower retention volume on Tenax GC. In contrast, di-n-butylamine had breakthrough volumes in the m^3 range. Similar differences were observed between pyridine and aniline. It was concluded that if the compound exhibited a high degree of basicity, the retention volume would be correspondingly high. However in those cases where steric hindrance plays an important role in reducing the basicity of the compound (e.g. t-butylamine), then the breakthrough volume will be decreased correspondingly.

Little differences are observed in the breakthrough volume between methyl ethyl ketone and methyl vinyl ketone. Comparison of acetone and acetophenone indicates again that the incorporation of an aromatic moiety will significantly increase the breakthrough volume. This trend is also observed when comparing acetaldehyde and benzaldehyde.

The breakthrough volumes for two nitrosamines, N-nitrosodimethylamine and N-nitrosodiethylamine are also shown in Table 4. The incorporation of two methylene units into the N-nitrosodimethylamine (to yield N-nitrosodiethylamine) produces a marked increase in the breakthrough volume. In fact, it increases by a factor of 9.

Surprisingly, the inorganic gases tested exhibited rather low or no retention volume at all (NO , NO_2 , Cl_2 , Br_2 , I_2 , and SO_2) on Tenax GC. The low retention index for these inorganic gases is an important factor when considering the formation of artifacts during the concentration of organic pollutants from ambient air. For example, when high concentrations of dimethylamine occur in ambient air, the possibility of artifact formation during sampling with a cartridge sorbent such as Tenax GC via a reaction between NO_x ($NO + NO_2$) and dimethylamine is highly unlikely since NO_x does not accumulate. Of particular importance is also the very low breakthrough volume for water on Tenax GC; water accumulating on the substrate may

Table 4. BREAKTHROUGH VOLUMES FOR SEVERAL ATMOSPHERIC POLLUTANTS^a

Chemical Class	Compound	b.p. (°C)	Temperature °F (°C)					
			50 (10)	60 (15.5)	70 (21.1)	80 (26.7)	90 (32.2)	100 (37.8)
acids	<u>n</u> -butyric acid	162	615	423	290	199	136	93
alcohols	methanol	64.7	1	1	0.8	0.6	0.4	0.3
	<u>n</u> -propanol	97.4	27	20	14	10	7	5
	ethylene glycol	196-8	137	96	67	47	33	23
	allyl alcohol	96-8	32	23	16	11	8	6
	dibromopropanol	95-7	120	84	58	41	28	20
aldehydes	acetaldehyde	20	3	2	2	1	0.9	0.7
	benzaldehyde	179	7,586	5,152	3,507	2,382	1,622	1,101
amines	dimethylamine	7.4	9	6	4	3	2	1
	isobutylamine	69	71	47	34	23	16	11
	<u>t</u> -butylamine	89	6	5	4	3	2	1
	di-(<u>n</u> -butyl)amine	159	9,506	7,096	4,775	3,105	2,168	1,462
	pyridine	115	378	267	189	134	95	67
	aniline	184	8,128	5,559	3,793	2,588	1,766	1,205
aromatics	benzene	80.1	108	77	54	38	27	19
	toluene	110.6	494	348	245	173	122	86
	ethylbenzene	136.2	1,393	984	693	487	344	243
	cumene	152.4	3,076	2,163	1,525	1,067	750	527
	phenol	96-8	2,071	1,490	1,072	769	554	398
	<u>o</u> -bromophenol	195	2,872	2,124	1,567	1,159	855	633
	<u>m</u> -bromophenol	236	6,269	4,701	3,534	2,650	1,987	1,490
	<u>p</u> -bromophenol	235-6	7,966	5,946	4,428	3,298	2,456	1,829
	biphenyl	256	62,405	44,383	31,639	22,502	16,046	11,408

(continued)

Table 4 (cont'd)

Chemical Class	Compound	b.p. (°C)	Temperature °F (°C)					
			50 (10)	60 (15.5)	70 (21.1)	80 (26.7)	90 (32.2)	100 (37.8)
esters	ethyl acetate	77	162	108	72	48	32	22
	methyl acrylate	80	164	111	75	50	34	23
	methyl methacrylate	100	736	484	318	209	137	90
ethers	diethyl ether	34.6	29	21	15	11	8	5
	propylene oxide	35	13	9	7	5	4	3
halogenated ethers	2-chloroethyl ethyl ether	108	468	336	241	234	124	89
	Bis-(chloromethyl)ether	-	995	674	456	309	209	142
halogenated hydrocarbon	methyl chloride	-24	8	6	5	4	3	2.5
	methyl bromide	3.5	3	2	2	1	1	0.9
	vinyl chloride	13	2	1.5	1.25	1.0	0.8	0.6
	vinyl bromide	16	8	6	4	3	2	1.8
	methylene chloride	41	11	9	7	5	4	3
	chloroform	61	42	31	24	18	13	10
	carbon tetrachloride	77	34	27	21	16	13	10
	1,2-dichloroethane	83	53	41	31	23	18	14
	1,1,1-trichloroethane	75	23	18	15	12	9	7
	tetrachloroethylene	121	361	267	196	144	106	78
	trichloroethylene	87	90	67	50	38	28	21
	1-chloro-2-methylpropene	68	26	20	16	12	9	7
	3-chloro-2-methylpropene	72	29	22	17	13	10	8
	1,2-dichloropropane	95	229	162	115	81	58	41
	1,3-dichloropropane	121	348	253	184	134	97	70
	epichlorohydrin (1-chloro-2,3-epoxypropane)	116	200	144	104	74	54	39

(continued)

Table 4 (cont'd)

Chemical Class	Compound	b.p. (°C)	Temperature °F (°C)					
			50 (10)	60 (15.5)	70 (21.1)	80 (26.7)	90 (32.2)	100 (37.8)
	epibromohydrin (1-bromo-2,3-epoxypropane)	134-6	678	479	337	237	168	118
	trimethylene chlorobromide	142-5	1,130	927	656	465	329	233
	3-chloro-1-butene	64	19	15	12	9	7	6
	allyl chloride	45	21	16	12	9	6	5
	4-chloro-1-butene	75	47	36	27	20	15	12
	1-chloro-2-butene	84	146	106	77	56	40	29
	chlorobenzene	132	899	653	473	344	249	181
	<u>o</u> -dichlorobenzene	181	1,531	1,153	867	656	494	372
	<u>m</u> -dichlorobenzene	173	2,393	1,758	1,291	948	697	510
	benzyl chloride	179	2,792	2,061	1,520	1,125	330	612
	bromoform	149	507	386	294	224	171	130
	ethylene dibromide	131	348	255	188	138	101	74
	bromobenzene	155	2,144	1,521	1,079	764	542	384
hydrocarbons	<u>n</u> -hexane	68.7	32	23	17	12	9	6
	<u>n</u> -heptane	98.4	143	104	75	55	39	29
	1-hexene	63.5	28	20	15	11	8	6
	1-heptene	93.6	286	196	135	93	64	44
	2,2-dimethylbutane	49.7	0.5	0.4	0.3	0.2	0.2	0.1
	2,4-dimethylpentane	80.5	62	44	31	22	15	11
	4-methyl-1-pentene	53.8	14	10	8	6	4	3
	cyclohexane	80.7	49	36	26	19	14	10

(continued)

Table 4 (cont'd)

Chemical Class	Compound	b.p. (°C)	Temperature °F (°C)					
			50 (10)	60 (15.5)	70 (21.1)	80 (26.7)	90 (32.2)	100 (37.8)
inorganic	nitric oxide	-	0	0	0	0	0	0
	nitrogen dioxide	-	0	0	0	0	0	0
	chlorine	-	0	0	0	0	0	0
	bromine	58.7	0.035	0.025	0.020	0.015	0.010	0.010
	iodine	184.3	0.037	0.025	0.022	0.021	0.015	0.010
	sulfur dioxide	-	0.06	0.05	0.03	0.02	0.02	0.01
	water	100	0.06	0.05	0.04	0.03	0.01	0
ketones	acetone	56	25	17	12	8	6	4
	methyl ethyl ketone	80-2	82	57	39	27	19	13
	methyl vinyl ketone	81	84	58	40	28	19	14
	acetophenone	202	5,346	3,855	2,767	2,000	1,439	1,037
nitrosamines	N-nitrosodimethylamine	151	385	280	204	163	148	107
	N-nitrosodiethylamine	177	2,529	1,836	1,330	966	700	508
nitrogenous hydrocarbons	nitromethane	101	45	34	25	19	14	11
	aniline	184	3,864	2,831	2,075	1,520	1,114	817
Oxygenated hydrocarbons	acrolein	53	19	14	10	8	6	4
	glycidaldehyde	-	364	247	168	114	77	52
	propylene oxide	34	35	24	17	11	8	5
	butadiene diepoxide	-	1,426	1,009	714	506	358	253
	cyclohexene oxide	132	2,339	1,644	1,153	811	570	400
	styrene oxide	194	5,370	3,926	2,870	2,094	1,531	1,119
	phenol	183	2,071	1,490	1,072	769	554	398
	acetophenone	202	3,191	2,382	1,778	1,327	991	740
	β-propiolactone	57	721	514	366	261	186	132

(continued)

Table 4 (cont'd)

Chemical Class	Compound	b.p. (°C)	Temperature °F (°C)					
			59 (10)	60 (15.5)	70 (21.1)	80 (26.7)	90 (32.2)	100 (37.8)
sulfur compounds	diethyl sulfate	208	40	29	21	15	11	8
	ethyl methane sulfate	86	5,093	3,681	2,564	1,914	1,384	998
	<u>t</u> -butyl mercaptan	62-5	3.5	3.0	2.5	2.0	1.9	1.5
	<u>n</u> -propylmercaptan	68-8	104	71	49	34	23	16
	sec-butylmercaptan	84-5	217	151	106	74	52	36
	diethyl sulfide	92	324	227	159	111	77	54
	<u>t</u> -amylmercaptan	99-105	180	129	92	65	47	33
	sec-isoamylmercaptan	117-8	399	286	204	146	104	74
	<u>n</u> -amylmercaptan	126	262	182	127	88	61	43
	<u>n</u> -heptylmercaptan	173-6	10,098	6,954	4,789	3,305	2,276	1,567
	di- <u>n</u> -butylsulfide	182	7,537	5,373	3,830	2,730	1,946	1,387
	thiophene	84	199	138	96	67	46	32
	2-methylthiophene	113	526	371	262	184	130	91
	2-ethylthiophene	132-4	910	659	478	346	251	182
	2-acetylthiophene	214	5,665	4,132	3,021	2,204	1,608	1,175
	2-mercaptoethanol	157	610	418	286	196	134	92
	diethyl sulfite	157-9	2,319	1,641	1,162	823	582	411
	dimethyl sulfoxide	189	524	391	292	218	163	122

^aBreakthrough volumes are based on 2.2 g of Tenax GC.

otherwise provide a medium for reactions such as hydrolysis of reactive species and/or formation of nitrous acid.

The breakthrough volumes for a number of sulfur containing compounds are also given in Table 4. A series of mercaptans, thiophenes and other sulfur containing compounds was studied. A direct relationship was observed between an increase in the boiling point of each compound and its breakthrough volume.

EXAMINATION OF SKC CARBON AS A BACKUP SORBENT FOR TENAX GC

The principal difficulty encountered in field use of a backup sorbent which has an affinity higher than Tenax GC has been the collection of excessive quantities of water. Unfortunately those commercial sorbents which have a higher affinity than Tenax GC for volatile organics also have a higher affinity for water. Most of the water could be eliminated by desorbing the backup cartridge with a low volume of carrier gas and trapping the vapors on Tenax. This would be similar to the back flushing techniques that are used in gas chromatography. In order for this to be an effective method of reducing the amount of water and to be a quantitative procedure for organic pollutants, it is necessary that the breakthrough volume for water be exceeded during purging without approaching the breakthrough volumes of the components of interest.

There were four requirements which were deemed necessary for a satisfactory material to be used as a backup sorbent: (1) the material must have a higher affinity for the polar organic vapors than for Tenax GC, (2) even though it may have a greater affinity for water, water must have a finite elution volume at ambient temperature, i.e. it must not be strongly retained to the sorbent so that adsorption properties for other compounds are not altered; (3) the sorbent material must allow the recovery of vapors by thermal desorption without introducing decomposition of the trapped constituents, and (4) during the thermal desorption cycle, the sorbent must not be decomposed with the formation of volatile background components or be altered such that its performance characteristics are also changed.

This section describes the examination of three silicones chemically bonded to Spherosil (100 microns) and SKC Lot No. 104 carbon. The chemically bonded stationary phases studied were an SLA075, SLB075, and SLC075 on 100-200 μ silica (Supelco, Inc., Bellefonte, PA).

Experimental

An apparatus for transferring adsorbed vapors from backup cartridges to Tenax cartridges was constructed which consisted of a cartridge holder mounted on the exhaust line of the thermal desorption unit.⁽²⁾ The inlet line end of the Tenax cartridge was attached to a Beckman (830511) 16-18 mm Teflon reducing union which was bored out to 8 mm i.d. and fitted with a Teflon insert (i.d. 2 mm) to minimize dead volume. The effluent carrier gas passed from the desorption chamber into the Tenax GC cartridge and then through a soap bubble flow meter followed by a carbon safety trap.

Results and Discussion

Preliminary experiments were conducted with Chromosorb 104 to test the transfer procedure from one cartridge to another. The Chromosorb 104 cartridges were desorbed at 280°C for 20 min and then a Tenax cartridge was desorbed further 20 min at 50 ml/min at helium purge. The Tenax GC cartridge was then removed from the line and desorbed at 270°C and analyzed by gc@fid. The background eluting from Chromosorb 104 after a 20 min desorption period at 200° was excessively high so desorption was continued for 15 hrs to further condition the sorbent. Then a Tenax GC cartridge was loaded for 20 min with Chromsorb 104 cartridge at 200°C. This was repeated at 180°. Both Tenax cartridges had approximately 10 times their normal background. Chromosorb 104 could be used as a backup material for Tenax, but due to the excessive background it would be impractical for use in quantitative analysis. Accordingly, it was given no further consideration.

The first criteria evaluated for the chemically bonded silicones to Spherosil was the determination of background occurring from the sorbent during thermal desorption. Sorbents were loaded into cartridges (1.5 x 6 cm bed) and desorbed in a 50 ml/min helium stream for 30 min. The chemically bonded Spherosil were desorbed at 150° and the carbon at 270°. At the end of the desorption period, the background was determined by either cryogenic trapping of the effluent stream (-196°C) or 10 min or trapping vapors from the effluent stream with a 1.5 x 6 cm bed of Tenax for 10 min. Desorption was continued for a period of upto 110 min and the effluent was tested at 20, 40 and 90 min. The background for the chemically bonded phases on the Spherosil was comparable to that of Tenax GC. On the otherhand, the

background from SKC carbon which was much smaller, an initial desorption time of approximately 30 min was necessary to minimize background.

Preliminary test of collection efficiency for silicone chemically bonded to Spherosil was also run by sampling lab air with a Tenax GC cartridge in tandem with a Spherosil cartridge. The Spherosil cartridge was then thermally desorbed and analyzed. The results were compared with those from a Tenax backup cartridge which had been loaded with laboratory air simultaneously under the same sampling conditions. The quantities of vapors collected by the Spherosil backup cartridges were substantially smaller than those collected on the Tenax backup cartridge. From this it concluded that the affinity of organic vapors for the chemically bonded Spherosil tested was substantially smaller than their affinity for Tenax GC. Thus, they would not be suitable backup sorbents for Tenax and no further consideration was given to them.

Experiments were conducted to examine the recovery of vinyl chloride from SKC carbon and the possibility of transferring desorbed volatile organic vapors from carbon to Tenax GC cartridges. One of the problems associated with the use of carbon cartridges for sampling has already been mentioned earlier. i.e. the accumulation of significant amounts of water. In order to transfer the volatile organic vapors from the carbon cartridge to the analytical system, the water which is desorbed must be eliminated. It has been our experience that the direct interfacing of the SKC carbon cartridge to the analytical system produces icing and plugging of the capillary trap on the inlet manifold which is used to concentrate and transfer the organic vapors to the SCOT capillary column.

Vinyl chloride standards were prepared from a standard source of concentration of 10 ppm. A standard amount (250 ng) was loaded onto a cartridge and experiments in which the desorption of the vinyl chloride from SKC carbon was directly introduced into the analytical system. The desorption unit was operated at 290°C with the helium purge range of 30 ml/min. The desorbed vapors were trapped in a 0.5 ml i.d. x 0.5 m length, trans-axial Ni capillary trap cooled with liquid nitrogen. Vinyl chloride vapors desorbed and analyzed in this manner were compared to the response of an equivalent amount loaded onto Tenax GC cartridges (1.5 x 6 cm).

Analysis were performed on a Perkin-Elmer 900 gas-liquid chromatograph equipped with a 400 ft OV-101 stainless steel SCOT capillary programmed from 30-240°C at 4°/min with a 4 min delay. The carrier gas flow was 4 ml/min. The response obtained for the peak corresponding to vinyl chloride desorbed from Tenax was taken as a reference response (250 ng).

A 1.5 cm i.d. x 4 cm bed of SKC carbon was loaded on one end with vinyl chloride and placed into the thermal desorption unit so that it was "down". The desorption of the cartridge and analysis indicated a response that was 95% of the standard response. When the vinyl chloride vapor was loaded in the middle of the cartridge with a hypodermic syringe, the response was 40% of the standard. In the third case, the vinyl chloride was loaded at one end of the carbon cartridge and introduced in the unit so that this end was "up". In this case the response was 40% of the standard. The desorption time in each case was 10 min.

The desorption of vinyl chloride from carbon onto a 6 cm Tenax GC cartridge was evaluated. Vinyl chloride was loaded onto carbon and the carbon cartridge desorbed at 290° for 6 min onto Tenax at a 30 ml/min He purge rate. The response of the detector obtained for the desorption of the Tenax GC cartridge was 40% of the vinyl chloride standard.

When a carbon cartridge which has been utilized in field sampling was desorbed for 10 min onto a Tenax cartridge, a considerable amount of water condensed on a glass wool plug which held the Tenax GC bed. During the desorption of the Tenax GC cartridge, the Ni capillary trap froze and the purged gas flow dropped to zero. Thus it was decided that a desiccant was needed in order to remove the water vapor.

A Tenax GC cartridge was then loaded with vinyl chloride and desorbed for 5 min onto another Tenax cartridge and when the backup Tenax cartridge was analyzed, the vinyl chloride response was 95% of the standard. This experiment was repeated using a 1.5 cm x 1 cm length of calcium sulfate bed placed in-line prior to the backup Tenax GC cartridge. The backup cartridge was then analyzed and the response was 40% of the standard. The Tenax GC cartridge was then loaded with vinyl chloride and desorbed for 15 min through the calcium sulphate plug and onto a backup Tenax GC cartridge. The response obtained in this case was 90% of the standard. It was concluded that an additional purged

volume through the calcium sulphate was necessary in order to exceed the breakthrough volume for vinyl chloride.

A carbon cartridge which had been used in field sampling was desorbed and purged for 15 min through the calcium sulphate drying tube and onto a Tenax cartridge. Calcium sulphate effectively reduced the amount of water vapor so that the capillary trap on the thermal desorption unit did not freeze when the Tenax cartridge was desorbed.

Using a smaller cartridge packed with SKC Lot No. 104 carbon (0.5 cm x 4 cm in length), the collection and recovery by thermal desorption utilizing the calcium sulphate drying tube and the desorption of the backup Tenax cartridge yielded a 95% or better recovery of vinyl chloride.

Since the above experiments indicated that it was feasible to desorb vinyl chloride from SKC carbon Lot 104 and transfer it to Tenax cartridges for further analysis, we then investigated the breakthrough volumes of vinyl chloride, vinyl bromide, methyl chloride and methyl bromide on this SKC charcoal. The method for estimating the breakthrough volumes has been previously described.^(1,2,4) Tables 5 and 6 present the breakthrough volumes for vinyl chloride, vinyl bromide, methyl chloride and methyl bromide on this SKC charcoal (104). For vinyl chloride the breakthrough volume increased from 0.9 l/g for Tenax to 104 l/g of SKC charcoal (50°F in both cases). Thus the increase in the retention volume for the vinyl chloride was approximately 2 orders of magnitude greater than that of Tenax GC. Similar results were observed with vinyl bromide whereby breakthrough volume on Tenax GC increased from 3.6 l/g to 388 l/g of SKC charcoal (also 50°F). Again, the increase in the breakthrough volume was approximately 2 orders of magnitude. Comparison of the breakthrough volumes between Tenax and SKC charcoal for methyl chloride and methyl bromide indicated a significant increase in the breakthrough volume when using charcoal. These results indicate that the SKC carbon provides an adequate sorbent material for the collection of vinyl chloride, vinyl bromide, methyl chloride and methyl bromide with significantly higher breakthrough volumes which will allow more sensitive analysis and possibly quantification of these compounds in ambient air.

Based on the results of the breakthrough volumes of compounds on Tenax GC and SKC charcoal Lot No. 104, it was concluded that the SKC charcoal could serve as a backup to Tenax GC for those sampling strategies requiring the

Table 5. ESTIMATION OF BREAKTHROUGH VOLUMES FOR
VINYL CHLORIDE AND VINYL BROMIDE ON SKC
CHARCOAL (104)

Temperature °C (°F)	Vinyl Chloride		Vinyl Bromide	
	ℓ/g	ℓ/2.52 g ^a	ℓ/g	ℓ/2.52 g ^a
10 (50)	104	262	388	978
15.5 (60)	81	204	306	771
21.1 (70)	63	159	241	608
26.7 (80)	49	123	190	479
32.2 (90)	38	96	150	378
37.8 (100)	30	76	118	298

^aA 1.5 cm i.d. x 4.0 cm bed of charcoal weighs 2.52 g.

Table 6. ESTIMATION OF BREAKTHROUGH VOLUMES FOR
METHYL CHLORIDE AND METHYL BROMIDE ON
SKC CHARCOAL (104)

Temperature °C (°F)	Methyl Chloride		Methyl Bromide	
	ℓ/g	ℓ/2.52 g	ℓ/g	ℓ/2.52 g
10 (50)	14.3	36	98	248
15.5 (60)	11.1	28	75	188
21.1 (70)	8.7	22	57	143
26.7 (80)	7.5	19	43	108
32.2 (90)	5.6	14	32	82
37.8 (100)	4.4	11	25	62

collection and analysis of the more volatile compounds in ambient air. The feasibility of thermally desorbing and transferring to Tenax GC cartridges to eliminate the presence of high concentrations of water on the SKC charcoal cartridges was demonstrated in these experiments.

ESTIMATION OF RELATIVE MOLAR RESPONSE RATIOS FOR SEVERAL ORGANIC VAPORS

In the pursuit of a method for the quantification of organic vapors in the ambient air, several criteria must be addressed. The first is the determination of breakthrough volume on the sorbent material which is being utilized to trap the organic vapors from the ambient air. Secondly, the process of transferring the organic vapors trapped on the sorbent to the analytical system must be standardized in order to insure that quantitative recoveries are obtained. Another aspect which must be addressed is instrument calibration for determining the absolute quantity of each pollutant originally on the sampling cartridge. The utilization of a standard curve for all compounds to be quantified in ambient air is not feasible. One approach which can be used to circumvent the preparation of standard curves is the use of relative molar response ratios. Successful use of this method requires information on the exact amount of standard added and the relationship of RMR (unknown) to the RMR (standard).⁽⁵⁾

The use of the RMR method for quantifying ambient air pollutants is described here.

Experimental Method

The method of calculation for RMR is as follows:

$$(1) \text{ RMR}_{\text{unknown/standard}} = \frac{A_{\text{unk}}/\text{Moles}_{\text{unk}}}{A_{\text{std}}/\text{Moles}_{\text{std}}}$$

A = peak area, determined by integration or triangulation.

The value of RMR is determined from at least five independent analyses.

$$(2) \text{ RMR}_{\text{unk/std}} = \frac{A_{\text{unk}}/g_{\text{unk}}/\text{GMW}_{\text{unk}}}{A_{\text{std}}/g_{\text{std}}/\text{GMW}_{\text{std}}}$$

A = peak area, as above

g = number of grams present

GMW = gram molecular weight

Thus, in the sample analyzed:

$$(3) \quad g_{\text{unk}} = \frac{A_{\text{unk}} \cdot \text{GMW}_{\text{unk}} \cdot g_{\text{std}}}{A_{\text{std}} \cdot \text{GMW}_{\text{std}} \cdot \text{RMR}_{\text{unk/std}}}$$

The standard may be added as an internal standard during sampling. However, since the volume of air taken to produce a given sample is accurately known, it is more practical to use the external standard method whereby the standard is added to the cartridge after the sample has been collected in the field. Two external standards were selected. These were hexafluorobenzene and perfluorotoluene. The retention index for these external standards is such that the elution from the glass capillary column (OV-101) occurs at a temperature and time which does not interfere with the analysis of unknown compounds in ambient air samples.

Results and Discussion

Since the volume of air taken to produce a given sample is accurately known and an external standard was utilized, then grams (unknown)/volume (air) can be determined. In order to successfully utilize this technique, the RMR's for organic vapors must be determined either with authentic compounds which were identified in the ambient air or with their analogs.

The relative molar response factors for several compounds based upon the total ion current monitor of the GC/MS/COMP system is shown in Table 7. The RMR's were calculated using the two external standards, perfluorobenzene (PFB) and perfluorotoluene (PFT). The statistical variances and deviation are also indicated. As might be expected, the RMR values for aromatic hydrocarbons are quite similar to one another. Thus by choosing the appropriate RMR in a homologous series it can be utilized for calculating concentrations of constituents where the authentic compound is unavailable and its RMR is not known.

The RMR factors for hydrocarbons also reveal a very close similarity in a homologous series. The greatest variation occurs with the halogenated hydrocarbons. They may vary several fold.

The relative molar response values for several compounds based on selected ions are given in Table 8. In this case, a unique ion which is characteristic of that compound was selected and a relative molar response factor calculated relative to one of the ions selected for hexafluorobenzene (m/e 186). A second ion for each compound was also utilized for calculating

Table 7. RELATIVE MOLAR RESPONSE (RMR) FACTORS FOR SEVERAL
COMPOUNDS BASED UPON TOTAL ION CURRENT MONITOR

Chemical Class	Compound	PFB ^a			PFT ^a		
		RMR	Var. ^b	S.D. ^c	RMR	Var.	S.D.
Aromatic hydrocarbons							
	Toluene	2.38	0.020	0.15	2.48	0.110	0.33
	<u>o</u> -Xylene	2.90	0.170	0.42	2.33	0.200	0.41
	Cumene	1.56	0.050	0.22	1.76	0.026	0.16
	1,3,5-Trimethylbenzene	1.48	0.050	0.22	1.63	0.037	0.19
	1,2,4-Trimethylbenzene	1.47	0.025	0.16	1.47	0.006	0.08
	1,2,3-Trimethylbenzene	1.26	0.040	0.19	1.45	0.013	0.11
	Phenylacetylene	1.25	0.001	0.03	1.45	0.010	0.12
	Naphthalene	1.34	—	—	1.53	—	—
	α -Methylstyrene	1.88	0.001	0.01	2.04	0.004	0.06
	Indan	1.54	0.024	0.16	1.76	0.027	0.16
	Tetrahydronaphthalene	1.98	—	—	1.72	—	—
Oxygenated aromatic							
	Anisole	1.77	0.290	0.54	2.14	0.040	0.20
	Acetophenone	0.58	0.040	0.20	0.79	0.007	0.08
	Styrene oxide	0.35	0.030	0.16	0.35	0.020	0.14
	2-Methylbenzofuran	1.46	0.003	0.06	1.32	0.030	0.18
	<u>m</u> -Tolualdehyde	0.56	0.020	0.15	0.54	0.003	0.06
Hydrocarbons							
	<u>n</u> -Heptane	1.39	0.150	0.39	1.66	0.080	0.29
	<u>n</u> -Nonane	1.85	0.020	0.14	2.04	0.008	0.09
	<u>n</u> -Undecane	1.71	0.048	0.22	1.94	0.016	0.12
	<u>n</u> -Tridecane	1.31	0.130	0.36	1.44	0.110	0.34
	1-Heptene	1.84	0.001	0.04	2.01	0.001	0.04
	4-Vinyl-1-cyclohexene	1.59	0.040	0.22	1.84	0.010	0.10

(continued)

Table 7 (cont'd)

Chemical Class	Compound	PFB ^a			PFT ^a		
		RMR	Var. ^b	S.D. ^c	RMR	Var.	S.D.
Oxygenated hydrocarbons							
	Di- <u>n</u> -butyl ether	5.90	0.300	0.55	6.40	0.130	0.36
	2-Pentanone	2.84	0.260	0.41	2.94	0.060	0.240
	2-Ethylfuran	2.59	0.230	0.48	2.68	0.100	0.320
	Cyclohexene oxide	1.28	0.020	0.13	1.32	0.030	0.17
Halogenated hydrocarbons							
	Trichloroethylene	2.08	0.14	0.38	2.41	0.49	0.70
	Tetrachloroethylene	2.76	0.21	0.46	3.10	0.78	0.83
	Bis-(chloromethyl)ether	3.70	0.10	0.32	3.57	0.79	0.89
	2,3-Dichlorobutane (Rac.)	1.80	0.03	0.17	2.07	0.04	0.21
	2,3-Dichlorobutane (Meso)	2.01	0.03	0.18	2.16	0.01	0.12
	1-Chloro-2-bromoethane	-	-	-	5.34	0.02	0.14
	Trimethylene chlorobromide	-	-	-	6.55	0.02	0.40
	1,2-Dibromoethane	3.34	0.14	0.37	2.78	0.58	0.76
	Bromoform	3.68	-	-	3.31	1.71	1.31
Chlorinated aromatics							
	Chlorobenzene	2.10	0.007	0.03	2.47	0.04	0.20
	<u>o</u> -Chlorotoluene	2.06	0.04	0.19	2.31	0.01	0.11
	Benzyl chloride	2.00	0.03	0.18	1.68	0.03	0.18
	<u>m</u> -Dichlorobenzene	2.21	0.14	0.38	2.51	0.32	0.56
	Bromobenzene	3.90	-	-	3.08	2.10	1.45
Miscellaneous							
	<u>o</u> -Ethylaniline	1.62	0.170	0.41	1.28	0.060	0.25

^aPFB = perfluorobenzene, PFT = perfluorotoluene which were external standards.

^bVar. = statistical variance.

^cS.D. = standard deviation.

Table 8. RELATIVE MOLAR RESPONSE VALUES FOR SEVERAL ORGANIC COMPOUNDS BASED
UPON SELECTED IONS

Chemical Class	Compound	M.W.	1st Ion		2nd Ion	
			m/e (I)	RMR	m/e (I)	RMR
Halogenated hydrocarbons						
	Allyl bromide	120	120 (25)	3.25	122 (25)	3.25
	Bromobenzene	156	156 (78)	2.18	158 ()	
	Bromodichloromethane	162	129 (12)	1.54	85 (60)	6.16
	Bromoform	250	173 (100)	2.78	252 (10)	0.30
	1 or 2-Bromopropane	122	124 (20)	3.25	122 (20)	3.25
	1-Chloro-2-bromoethane	142	144 (15)	1.12	63 (100)	7.39
	1-Chloro-3-bromopropane	156	158 (60)	4.48	160 (12)	1.12
	1-Chloro-2,3-dibromopropane	234	157 (100)	9.46	159 (25)	2.37
	1,1-Dibromo-2-chloropropane	234	157 (100)	9.46	159 (25)	2.37
	Dibromochloromethane	206	129 (100)	6.53	208 (10)	0.70
	1,2-Dibromoethane	186	109 (95)	3.34	188 (2)	0.50
	1,2 or 1,3-Dibromopropane	200	123 (99)	3.37	202 (65)	2.21
	Methyl chloride	50	50 (100)	1.7	52 (32)	0.66
	Methyl bromide	94	94 (90)	1.9	81 (78)	
	Vinyl bromide	106	108 (75)	2.2	110 (10)	0.30
Aromatics						
	Toluene	92	91 (100)	2.37	64 (13)	0.66
	<u>o</u> -Xylene ^b	106	105 (26)	3.46	51 (10)	0.39
	Cumene ^b	120	120 (28)	1.98	79 (9)	1.47
	1,3,5-Trimethylbenzene ^b	120	120 (67)	2.08	119 (15)	0.75
	1,2,4-Trimethylbenzene ^b	120	120 (58)	2.44	119 (14)	0.80
	1,2,3-Trimethylbenzene ^b	120	120 (52)	1.56	119 (11)	0.52
	<u>m</u> -Tolualdehyde ^b	120	91 (100)	1.51	119 (71)	1.06
	Anisole	108	108 (100)	1.19	65 (76)	1.30
	Acetophenone	120	105 (100)	0.97	120 (29)	0.27
	Naphthalene	128	128 (100)	1.92	51 (12)	0.18

(continued)

Table 8 (cont'd)

Chemical Class	Compound	M.W.	1st Ion		2nd Ion	
			m/e (I)	RMR	m/e (I)	RMR
Oxygenated hydrocarbons	2-Ethylfuran	96	81 (100)	2.35	-	-
	2-Pentanone	86	43 (100)	1.98	57 (26)	0.14
	Cyclohexene oxide	96	83 (100)	0.51	-	-
Hydrocarbons	<u>n</u> -Nonane ^b	128	85 (22)	2.46	71 (20)	2.01
	<u>n</u> -Undecane ^b	156	85 (21)	3.40	156 (4)	0.89
	<u>n</u> -Tridecane ^b	184	71 (41)	3.50	85 (23)	1.99

^aRMR values relative to m/e 186 (100) for HFB.

^bRMR values relative to m/e 167 (18) for HFB.

the RMR factor in the event that the first ion saturated the instrument or was non-specific.

The relative response factors were in all cases calculated on the basis of quadruplicate determinations between the authentic compound and the external standard.

DETERMINATION OF THE OVERALL SENSITIVITY OF HIGH RESOLUTION GLC/MS/COMP FOR THE ANALYSIS OF AMBIENT AIR POLLUTANTS

In order to determine the overall utility and sensitivity of the gc/ms/comp technique for the quantification of the ambient air pollutants, the theoretical sensitivity limits were estimated. Based upon the breakthrough volumes for the compounds listed in Table 4 at an ambient air temperature of 70°F, the theoretical sensitivity for the collection, transfer of the organic pollutants from the cartridge to the analytical system and the response of the analytical system to the organic vapor were calculated for a number of compounds. These results are given in Table 9.

The estimated detection limit for a number of halogenated compounds reveals a variation over several orders of magnitude (Table 9). The low detection limits are directly proportional to the sensitivity of the instrumentation to the particular compound and to its breakthrough volume. Thus the higher the breakthrough volume, the lower the anticipated limit of detection for its analysis in ambient air. For example, the volatile compound vinyl bromide has an estimated detection limit of approximately 250 ng/m³ of ambient air, whereas the estimated detection limit for bromobenzene is 100 pg/m³ of air (Table 9).

The estimated detection limits for nitrosamines such as N-nitrosodimethylamine can be as low as 1.67 ppt (70°F).

Table 9. OVERALL THEORETICAL SENSITIVITY OF HIGH RESOLUTION
GAS CHROMATOGRAPHY/MASS SPECTROMETRY/COMPUTER ANALYSIS
FOR ATMOSPHERIC POLLUTANTS

Chemical Class		Estimated Detection Limit ^a	
		ng/m ³	ppt
Halogenated hydrocarbon	Vinyl bromide	250	57
	Bromoform	0.340	0.03
	Bromodichloromethane	1.300	0.22
	Dibromochloromethane	0.667	0.07
	1-Bromo-2-chloroethane	1.00	0.67
	Allyl bromide	5.00	1.04
	1-Bromopropane	5.200	1.06
	1-Chloro-3-bromopropane	0.150	0.01
	1-Chloro-2,3-dibromopropane	~0.100	<0.01
	1,1-Dibromo-2-chloropropane	~0.100	<0.01
	1,2-Dibromoethane	0.530	0.07
	1,3-Dibromopropane	~0.100	~0.01
	Epichlorohydrin	9.600	2.50
	(1-Chloro-2,3-epoxypropane)		
	Epibromohydrin	0.300	0.05
	(1-Bromo-2,3-epoxypropane)		
	Bromobenzene	0.100	0.02
	Methyl bromide	500	135
	Methyl chloride	2000	1000
	Vinyl chloride	800	333
	Methylene chloride	700	200
	Chloroform	200	420
	Carbon tetrachloride	250	400

(continued)

Table 9 (continued)

Chemical Class	Compound	Estimated Detection Limit ^a	
		ng/m ³	ppt
Halogenated hydrocarbon (cont'd)	1,2-Dichloroethane	32	8.15
	1,1,1-Trichloroethane	66	12.45
	Tetrachloroethylene	2.5	0.38
	Trichloroethylene	10	1.92
	1-Chloro-2-methylpropene	62	21.5
	3-Chloro-2-methylpropene	62	21.5
	3-Chloro-1-butene	83	28.8
	Allyl chloride	83	28.8
	4-Chloro-1-butene	38	13.2
	1-Chloro-2-butene	13	4.5
	Chlorobenzene	2.10	0.47
	<u>o</u> -Dichlorobenzene	1.00	0.06
	<u>m</u> -Dichlorobenzene	0.75	0.01
	Benzylchloride	0.65	0.01
Halogenated ethers	2-Chloroethyl ethyl ether	4.15	0.97
	Bis-(chloromethyl)ether	1.0	1.10
Nitrosamines	N-Nitrosodimethylamine	5.0	1.67
	N-Nitrosodiethylamine	3.0	0.74
Oxygenated	Acrolein	~100	56.5
	Glycidaldehyde	~59	19.5
	Propylene oxide	~60	25.5
	Butadiene diepoxide	~20	6.7

(continued)

Table 9 (continued)

Chemical Class	Compound	Estimated Detection Limit ^a	
		ng/m ³	ppt
Oxygenated hydrocarbons (continued)	Cyclohexene oxide	~10	2.5
	Styrene oxide	2	0.415
	Acetophenone	~2	~0.415
	β-Propiolactone	~3	~1.2
Nitrogenous Compounds	Nitromethane	8	~2.4
	Aniline	3.0	0.78
Sulfur Compounds	Diethyl sulfate	~50	-
	Ethyl methane sulfate	~5.0	-

^aLimits are calculated on the basis of the breakthrough volume for 2.2 g of Tenax GC, (at 70°F), capillary column performance and sensitivity of the mass spectrometer to that compound in the mass fragmentography mode of most intense ion.

SECTION 7

IDENTIFICATION AND QUANTIFICATION OF ORGANIC POLLUTANTS IN AMBIENT AIR FROM SEVERAL GEOGRAPHICAL LOCATIONS

The overall purpose of this program has been to examine ambient air for hazardous organic compounds, particularly those volatile vapors which pass through the conventional Hi-Vol glass fiber filters. In the past very little characterization has been performed on ambient air collected from geographical areas throughout the Continental U.S.

Information on the composition of ambient air is of course particularly important if we are to understand the health effects impact resulting from organic pollutants. The information gathered with regard to the composition and quantity of organic vapors will assist investigators in future studies to determine the epidemiological implications of the pollution which is occurring. Since to-date there is only a paucity of data available with regard to the types of organic pollutants and their concentrations in ambient air, this program was initiated in order to acquire a better understanding of the potential pollution problems confronting the populated areas around the U.S.

CHARACTERIZATION AND QUANTIFICATION OF AMBIENT AIR POLLUTANTS IN THE BALTIMORE, MD AREA

Previous studies on the analysis of ambient air surrounding an industrial site in Baltimore, MD revealed the presence of N-nitrosodimethylamine. ^(3,6) The quantification of DMN was also performed in the cited studies. ^(3,7) However, the previous studies on nitrosoamines only represent a small potential health problem since the complete characterization of the ambient air for volatile organics had not been conducted. For this reason, we undertook a study in order to obtain a more complete characterization of the ambient air so as to better understand the health impact of the organic vapor pollutants. Because nitrosoamines were found, it does not necessarily follow that these are the only compounds responsible for the health problems

(e.g. incidence of cancer) for the immediate populace since there is the important aspect of other pollutants interacting antagonistically or synergistically to exert the final health impact observed in humans.

This section presents the characterization and quantification of ambient air pollutants near an industrial area in Baltimore, MD (Fig. 1).

Experimental

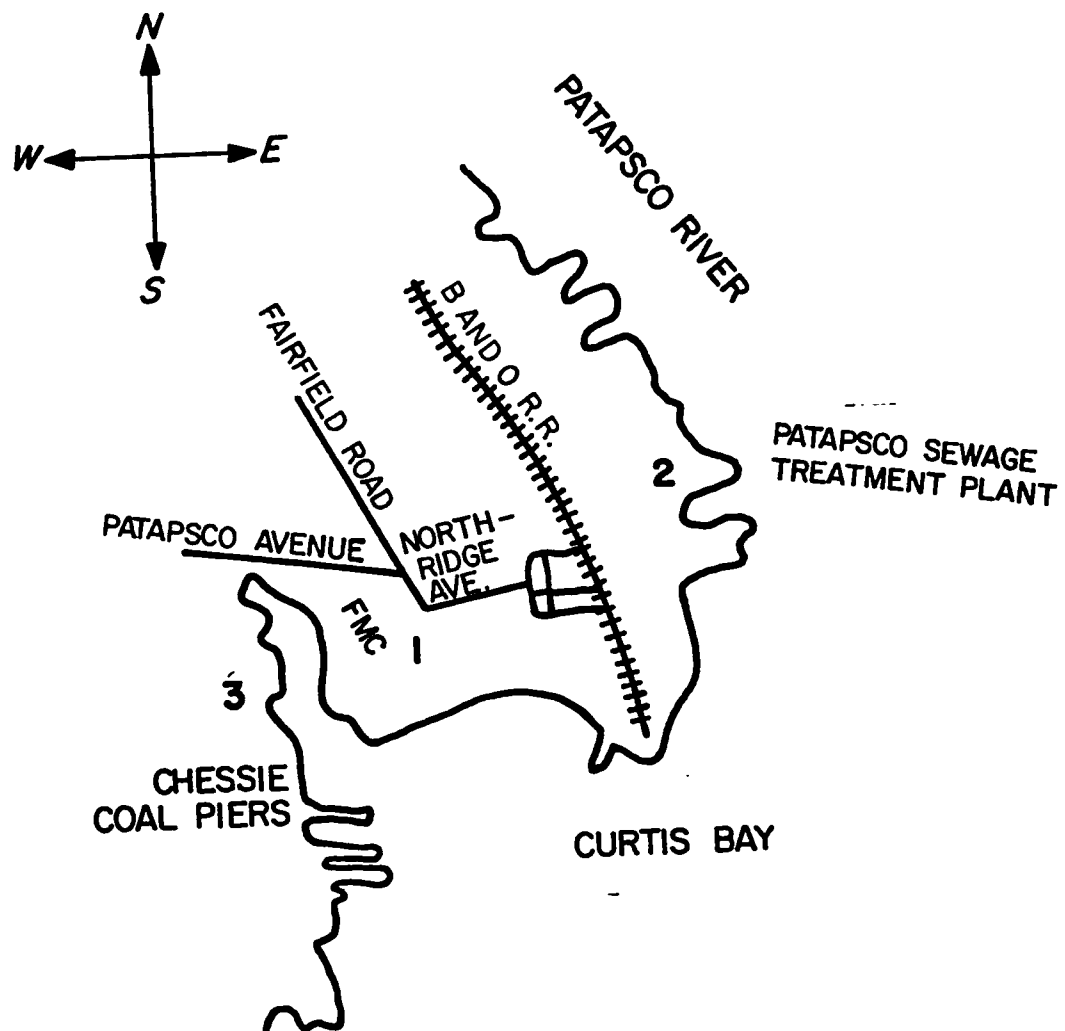
The sampling procedure employed for this study has been previously described⁽²⁾ which consisted of concentrating ambient air pollutants on a 1.5 x 6 cm bed of Tenax GC (35/60) in a glass cartridge. All of the sampling cartridges were preconditioned by heating to 275°C for a period of 20 min under helium purge (20-30 ml/min). Cartridges were cooled in precleaned Kimax[®] centrifuge tubes. The cartridge containers were immediately sealed to prevent contamination. Cartridges prepared in this manner were carried to the sampling site; 2-3 cartridges were designated as blanks to determine whether any of the cartridges were contaminated by the packing and transportation procedure.

Ambient air samples were collected with a Nutech Model 221-AC/DC portable sampler (Nutech Corp., Durham, NC). In general a sampling rate of 1 l/min/cartridge was used throughout this study (Table 10).

The instrumental system (glc/ms/comp) used for the qualitative and quantitative analysis of ambient air pollutants and the inlet manifold used for recovering vapors trapped on Tenax GC cartridge samplers were as described elsewhere.^(2,3) The desorbed vapors were resolved by glass capillary, gas-liquid chromatography and mass cracking patterns were automatically and continuously obtained throughout the glc run with a Varian MAT CH-7 gas chromatograph/mass spectrometer.

The operating parameters for the glc/ms/comp for analysis of samples collected on Tenax GC cartridges from the Baltimore, MD area are shown in Table 11. Ambient air samples were analyzed on a 100 m glass SCOT column coated with OV-101 stationary phase. The desorption of ambient air pollutants from the Tenax GC cartridge samplers was conducted at 265-270°C. A single stage glass jet separator interfaced the SCOT capillary column to the mass spectrometer and was maintained at 200°C.

Identification of resolved components was achieved by comparing the mass cracking pattern of the unknown mass spectra to an 8 major peak index



SCALE: ONE INCH = 0.5 miles

Figure 1. Map of sampling area in East Brooklyn, Baltimore, Maryland

Table 10. SAMPLING PROTOCOL FOR BALTIMORE AREA

Date	Time	Location	Temperature (°F)	RH (%)	Wind	
					Direction	Speed (KTS)
10/14/75	1100-1450	FMC (Parking Lot)	83	40-50	WNW	10
10/15/75	2300-0250	FMC (Parking Lot)	65	90-97	Calm	-
10/16/75	1000-1350	Sewage Plant	72	45-57	NNW	9-11
11/19/75	1400-1600	FMC, 200 yd W-NW of diamazine thermal destructor	65	56	E	3
11/24/75	1150-1350	FMC, SW of dia- mazine thermal destructor	-	-	-	-
11/24/75	1355-1555	FMC, SW of dia- mazine thermal destructor	-	-	-	-

Table 11. OPERATING PARAMETERS FOR GLC-MS-COMP SYSTEM

Parameter	Setting
Inlet-manifold	
desorption chamber	265°-270°
valve	175°
capillary trap - minimum	-195°C
maximum	+175°C
thermal desorption time	~4 min
GLC	
OV-101 glass SCOT (100 m)	30-225°C, 4°C/min
carrier (He) flow	1.5 ml/min
MS	
single stage glass jet separator	200°C
ion source vacuum	~2 x 10 ⁻⁶ torr
filament current	300 µA
multiplier	5.5
scan rate, automatic cyclic	1 sec/decade
scan range	m/e 20 → 300

of the mass spectra. (8,9) In several cases the identification was confirmed by comparing the mass spectrum and the elution temperature of the authentic compound with the unknown substance. Particular attention was paid to the relationship between the boiling point of the identified compound and its elution temperature and to the elution of constituents in a homologous series since the OV-101 SCOT capillary column separates primarily on the basis of boiling point.

The halogenated hydrocarbons in ambient air which were identified in these samples were quantitated. Standard curves for the response of the mass spectrometer vs the concentration of each of the identified halogenated hydrocarbons were prepared by introducing known quantities of vapor into the glc/ms system. Synthetic air halogenated hydrocarbon vapor mixtures were prepared in specified quantities trapped on Tenax GC cartridges. By thermally desorbing the cartridges and monitoring the total ion current, responses vs concentrations were obtained (Fig. 2). Cartridge samplers containing unknown concentrations of each of the halogenated hydrocarbons were analyzed by monitoring the total ion current and obtaining the quantity/cartridge from the standard curve. In those cases where baseline resolution was not achieved by the capillary column the technique of mass fragmentation (Section VI) was used instead of the total ion current. Based on the volume of air sampled and the breakthrough volume for each of the halogenated hydrocarbons (Section VI) the concentrations of the halogenated hydrocarbons in ambient air were calculated.

Results and Discussion

Characterization of Samples.--Figures 3 and 4 depict the profiles observed for ambient air samples taken near the FMC Corporation and the Patapsco Sewage Treatment Plant. A majority of the components shown in Fig. X were identified and are listed in Table 18 (Appendix I). In these samples, several halogenated compounds were identified. Those of particular interest were 1-chloro-2-methylpropene (dimethyl vinyl chloride, peak No. 6), 3-chloro-2-methylpropene (peak No. 7), 2,3-dichlorobutane (racemic, peak No. 33), and 2,3-dichlorobutane (meso, peak No. 35). The remaining halogenated compounds were typically of those which have been previously identified at other geographical areas within the Continental U.S.

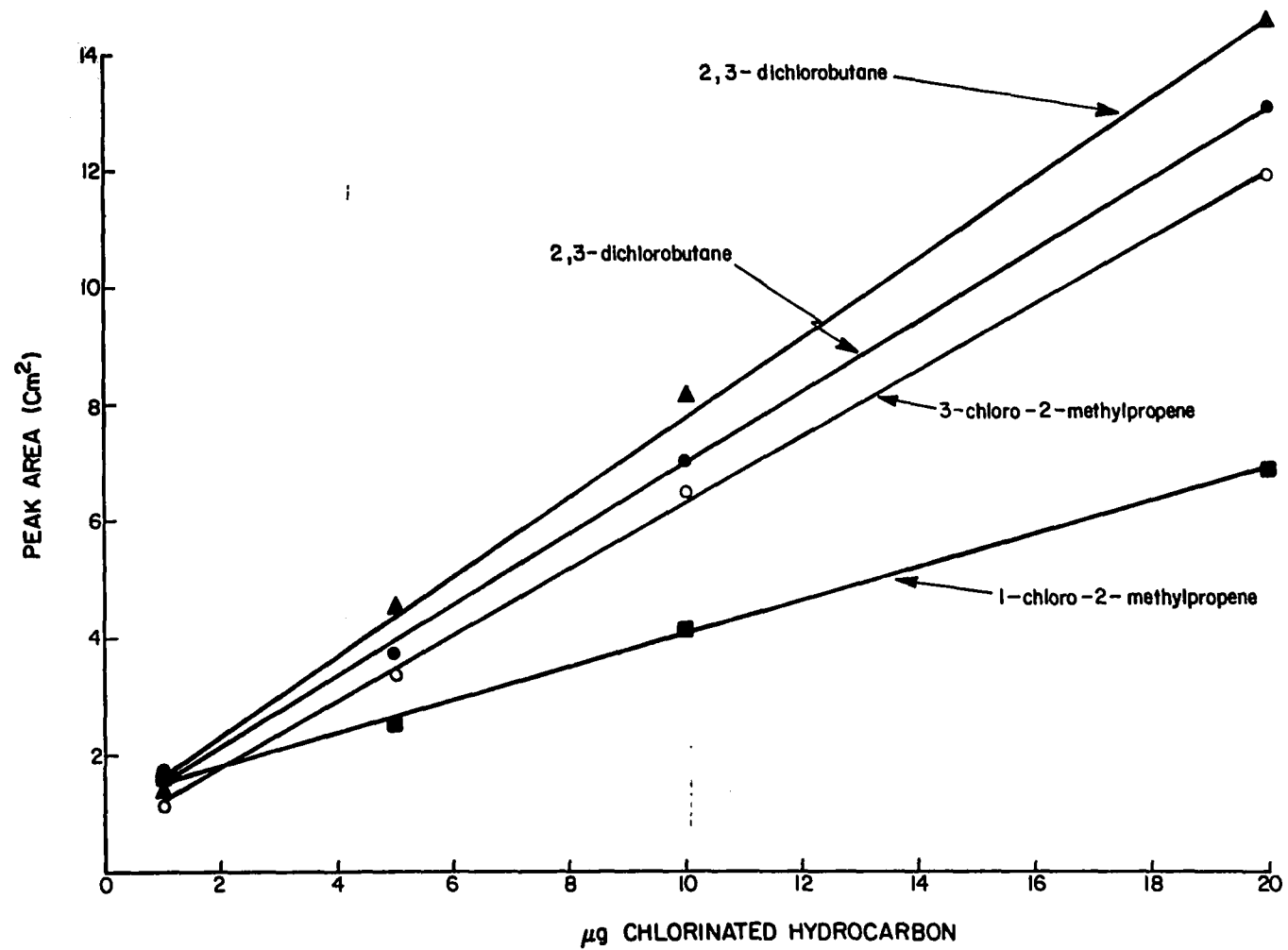


Figure 2. Standard linear regression curves for chlorinated hydrocarbons.

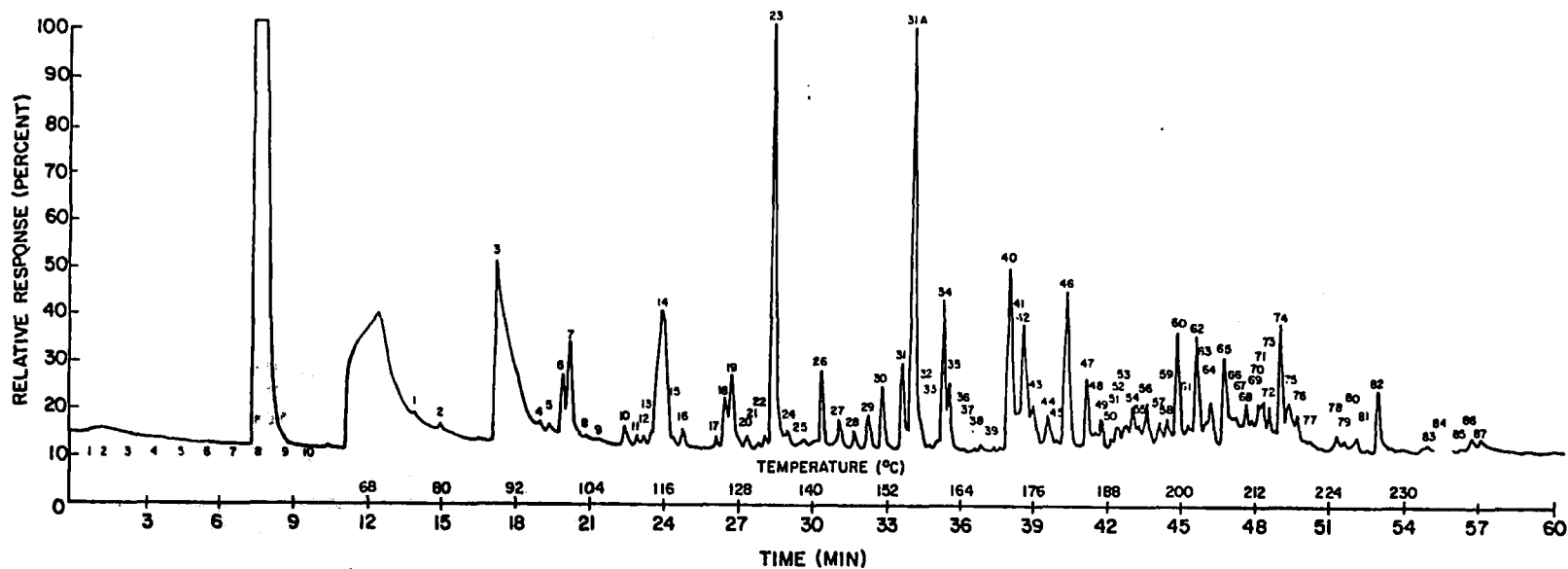


Figure 3. Profile of ambient air pollutants from industrial site in Baltimore, MD using high resolution gas chromatography/mass spectrometry/computer. A 100 m glass SCOT coated with OV-101 stationary phase was used; temperature programmed from 20-230°C @ 4°C/min.

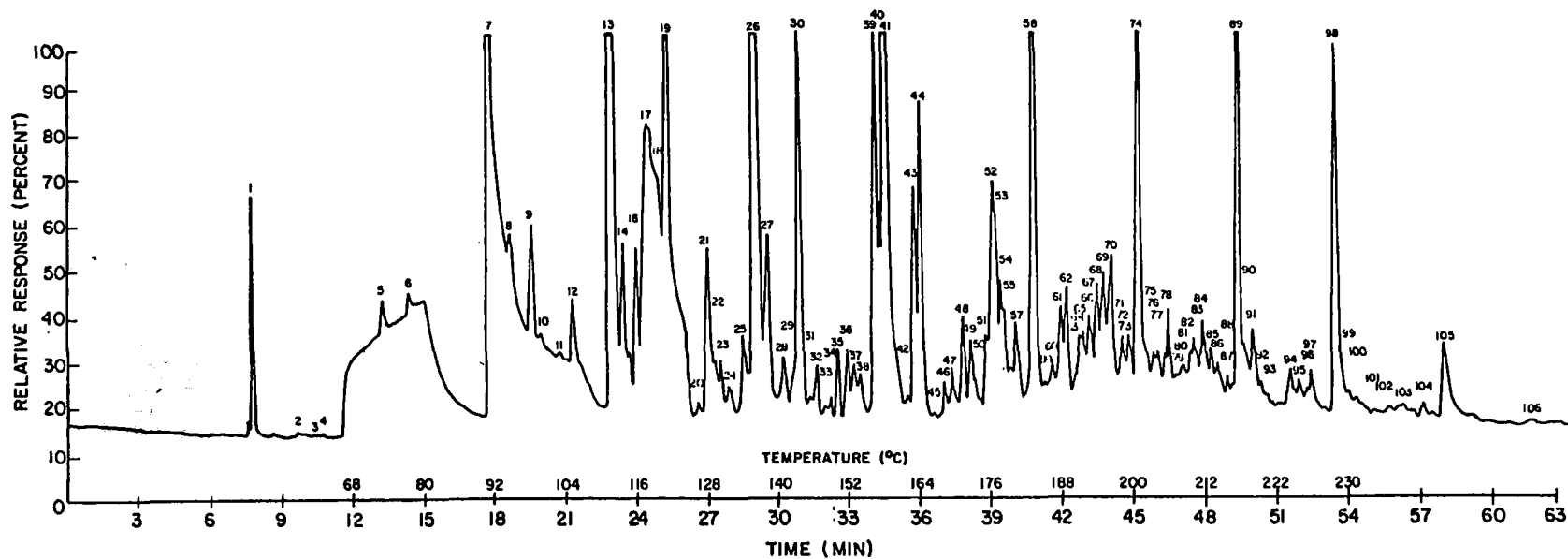


Figure 4. Profile of ambient air pollutants from Patapsco Sewage Treatment Plant in Baltimore, MD using high resolution gas chromatography/mass spectrometry/computer. A 100 m glass SCOT coated with OV-101 stationary phase was used; temperature programmed from 20-230°C @ 4°C/min.

The pollutants in Figure 3 are listed in Table 19 (Appendix I). In contrast to the samples obtained near the industrial site, this sample did not contain any of the previously described halogenated hydrocarbons. Several additional samples were taken in this area, and each revealed the presence of the four halogenated hydrocarbons described above. Because of the sampling strategy employed, it was not possible to attribute the emissions to the most immediate industrial site. The meteorological conditions in combination with the sampling protocol employed did not allow differentiation in the source of these compounds. Tables 19-22 (Appendix I) list additional identified pollutants.

Quantification of Halogenated Hydrocarbons in Ambient Air.--Table 12 depicts the sampling conditions and the concentrations of halogenated hydrocarbons observed in ambient air from an industrial area in Baltimore, MD. On two separate occasions during the month of October and November, the concentration of the four identified halogenated hydrocarbons were determined. The highest concentration observed was for dimethyl vinyl chloride which occurred in samples taken on the FMC property during the evening hours. Dimethyl vinyl chloride reached a level of 670,000 ng/m³ of ambient air. The lowest levels were approximately 100,000 ng which were detected for the month of November. The second most prominent halogenated hydrocarbon was an isomer of dimethyl vinyl chloride, 3-chloro-2-methylpropene which obtained a level of 400,000 ng/m³. Inspection of the data reveals that a correlation is evident between the concentrations of each of the halogenated hydrocarbons and the particular sampling time. Since their levels appear to increase and decrease simultaneously, this suggests that the same point source of emission is responsible for all four of the compounds.

In contrast to the above observations for the halogenated hydrocarbons near an industrial site, a sample of ambient air which was taken at the Patapsco Sewage Treatment Plant did not yield any measurable levels of the four halogenated hydrocarbons.

An interesting observation is that 2,3-dichlorobutane may exist as a racemic mixture and also as a meso pair. Although the racemic pair is theoretically possible, we only observed one isomer in the samples in which 2,3-dichlorobutane was detected. Authentic compounds of the four halogenated hydrocarbons were subjected to high resolution gas

Table 12. SAMPLING CONDITIONS AND CONCENTRATION OF HALOGENATED HYDROCARBONS IN AMBIENT AIR

Date	Time (EDT)	Location	Temperature (°F)	RH	Wind		Concentration ($\mu\text{g}/\text{m}^3$) ^a			
					Direction	Speed (KTS)	1	2	3	4
10/14/75	11:00 AM-2:50 PM	FMC (Parking Lot)	83	40-50	WNW	10	200	280	50	75
10/14/75	11:00 PM-2:50 AM	FMC (Parking Lot)	65	90-97	Calm	-	670	400	156	115
10/16/75	10:00 AM-1:50 PM	Sewage Plant	72	45-75	NNW	9-11	ND	ND	ND	ND
11/24/75	6:35 PM-8:35 PM	FMC	50	70	S-SW	4	100	110	26	32
11/25/75	1:48 PM-3:48 PM	FMC	55	73	SW-S	3-6	90	175	22	47

^a1 = 1-chloro-2-methylpropene, 2 = 3-chloro-2-methylpropene, 3 = 2,3-dichlorobutane (meso), 4 = 2,3-dichlorobutane (one of the racemic pairs).

chromatography/mass spectrometry and the retention time and mass cracking patterns were determined for the identity of each constituent (Fig. 5). While establishing the retention time of the halogenated hydrocarbons, we observed that an authentic sample of 2,3-dichlorobutane was a racemic mixture. The high resolution glass capillary columns effected baseline separation of the two racemic isomers as well as complete resolution from the meso pair of 2,3-dichlorobutane. Since the various isomeric forms were completely separated, we were able to then deduce whether the meso and racemic pairs were present in the ambient air samples. Indeed the meso form was observed, however only one isomer of the racemic pair was detected. Figure 5 depicts the resolution of the four authentic halogenated hydrocarbons.

ANALYSIS OF AMBIENT AIR FROM THE KANAWHA VALLEY, WV

A study had been conducted in the Kanawha Valley for the analysis of nitrosoamines in ambient air.^(6,7) Concurrent with this analysis and under this program, a broader more complete characterization of the organic pollutants in ambient air was also conducted. This section describes the characterization and quantification of organic compounds in ambient air taken from several sites within the Kanawha Valley.

Experimental

Ambient air sampling at several locations in the Kanawha Valley was conducted in a similar manner as described for the Baltimore project. The sampling protocol for selected sites in this valley is given in Table 13. Figures 6 and 7 depict the sampling locations in Belle and South Charleston, WV. The principal sites were on the E. I. DuPont Nemours property in Belle and Union Carbide in South Charleston.

The characterization and quantification of organics were as previously described.

Results and Discussion

The identification and estimation of several organic vapors are given in Tables 23-25 (Appendix I). Many organic vapors were identified. Those of particular interest were vinyl chloride, acetaldehyde, benzene, dimethylformamide, hexyl methacrylate, alkyl amines, chloroform, ethyl acetate, carbon tetrachloride, methyl chloroform, acetone, etc. The concentrations of some of these compounds are given in Table 14.

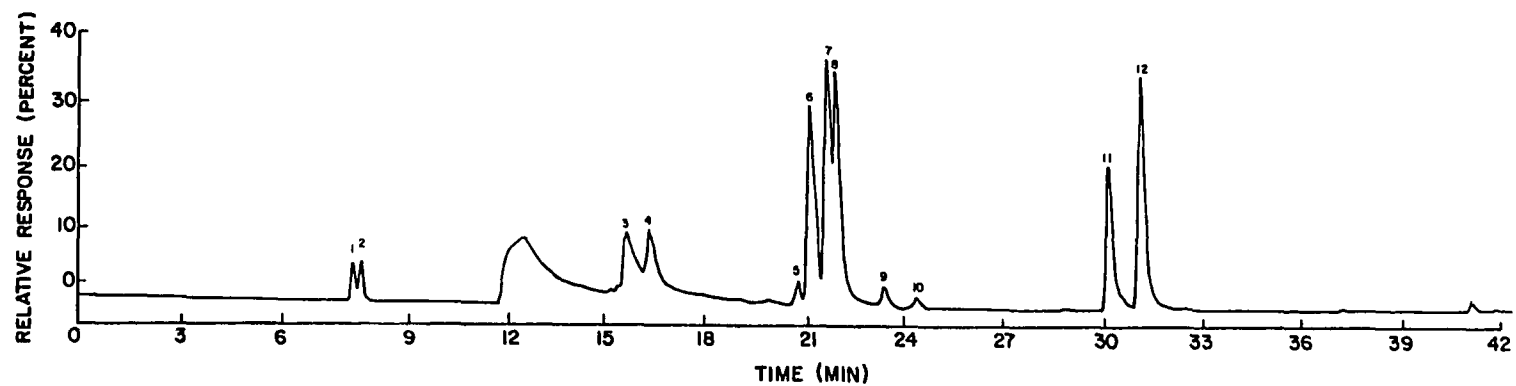


Figure 5. Resolution of ⁴ standard mixture of chlorinated hydrocarbons using a 90 m glass SCOT coated with OV-101 stationary phase. Temperature programmed from 20-225°C @ 4°C/min.

Table 13. AMBIENT AIR SAMPLING PROTOCOL FOR SELECTED AREAS IN THE KANAWHA VALLEY, WV

Site	Location	Sampling Period	m ³ /cartridge	Remarks
Belle, WV	1	9:30 pm-2:17 am	0.247	12/1/75 - 30°F - Wind NW - 5 mph
Belle, WV	2	9:30 pm-2:19 am	0.275	12/1/75 - 30°F - Wind NW - 5 mph
Belle, WV	4	10:05 pm-3:00 am	0.406	12/2/75 - ~40°F - Wind SE - 0-5 mph
S. Charleston, WV	9	2:41 pm-4:00 pm	0.248	12/3/75 - 55°F - Wind WSW→NW - 0-3 mph
S. Charleston, WV	10	3:12 pm-5:12 pm	0.350	12/3/75 - 55°F - Wind WSW→NW - 0-3 mph
S. Charleston, WV	14	8:47 pm-10:44 pm	0.324	12/3/75 - 44°F - Wind N→NNE - 3 mph
Belle, WV	6	3:26 pm-5:24 pm	0.256	12/4/75 - 66°F - Wind NE - 2 mph
Belle, WV	7	4:00 pm-6:05 pm	0.280	12/4/75 - 65°F - No wind
Belle, WV	8	7:06 pm-9:06 pm	0.348	12/4/75 - 65°F - Wind NE - 0-3 mph
Nitro, WV	15	11:58 am-3:48 pm	1.593	12/5/75 - 65°F - Wind S - 10 mph

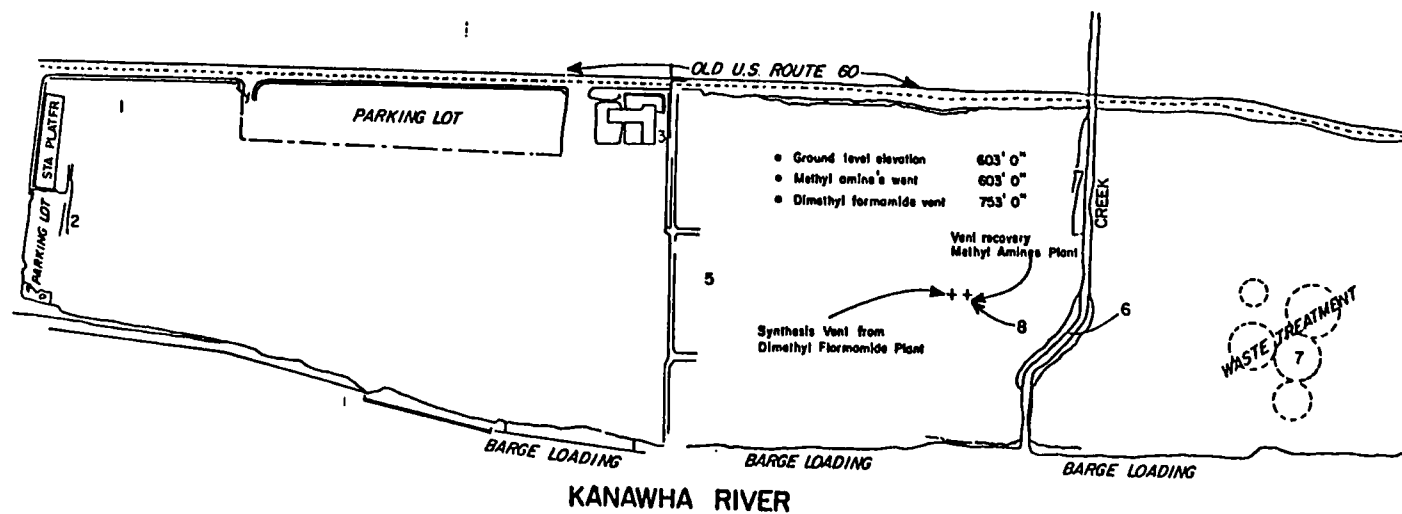


Figure 6. Plant map of DuPont in Belle, WV depicting sampling locations.

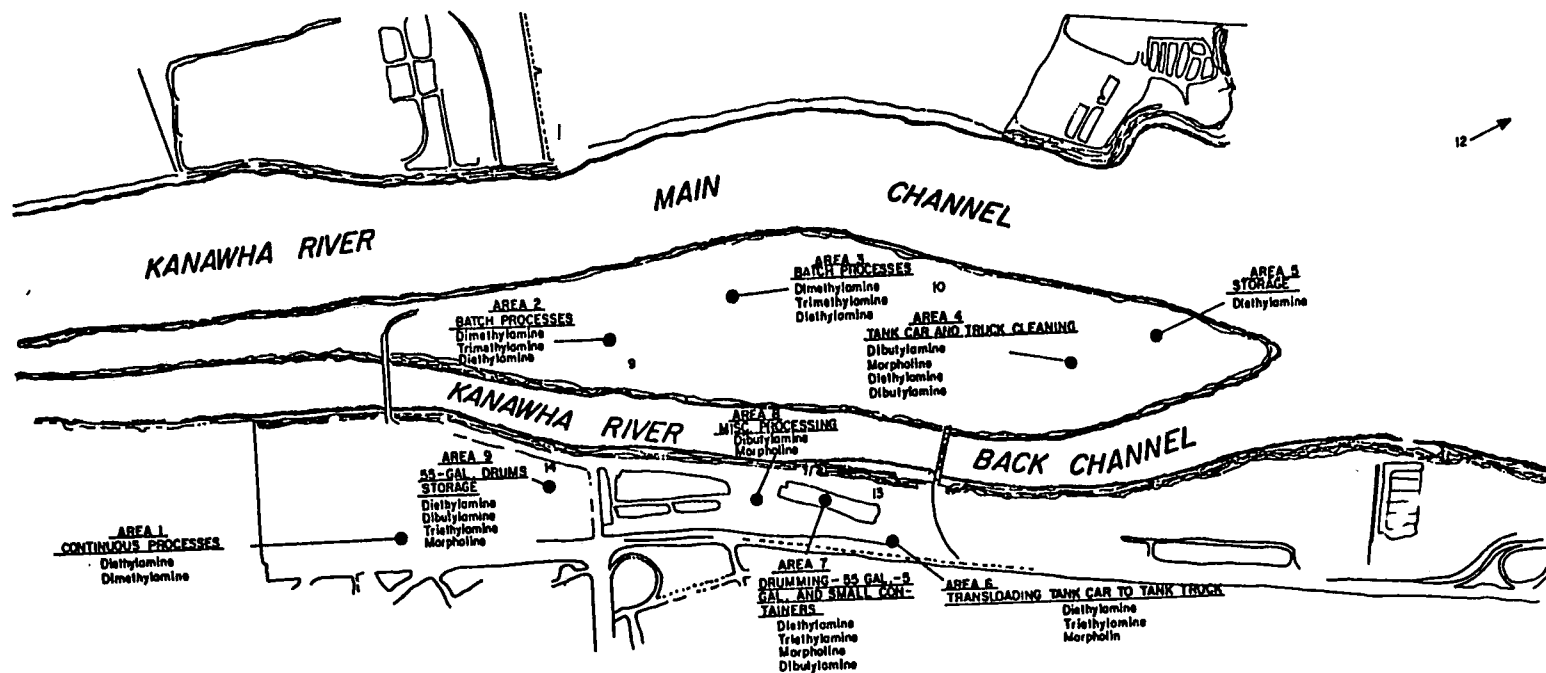


Figure 7. Plant map of Union Carbide in South Charleston, WV depicting sampling locations.

Table 14. AMBIENT AIR LEVELS OF SEVERAL POLLUTANTS
IN THE KANAWHA VALLEY, WV^a

Compound	Site		
	Belle	South Charleston	Nitro
Vinyl chloride	~2-4,000	trace	50,000
Acetaldehyde	~9,800	trace	trace
Acetone	trace	~100,000	>125,000
Methylene chloride	8,700	trace	>75,000
Chloroform	trace	~105,000	>39,000
Carbon tetrachloride	trace	~60,000	ND
Benzene	~400,000	~140,000	~150,000
N,N-Dimethylformamide	~76,700	ND	ND
γ-Butyrolactone (tent.)	ND ^b	3,750	ND
Ethyl acetate	ND	~70,000	trace

^aValues are in ng/m³

^bND = not detected

QUALITATIVE AND QUANTITATIVE ANALYSIS OF VOLATILE ORGANIC POLLUTANTS NEAR A CHEMICAL DISPOSAL SITE

The objective of this study was to determine the composition and concentrations of organic volatiles occurring in ambient air near a disposal site in Edison, NJ. The landfill site was located on the north bank of the Raritan River at the end of Mill Road. Large quantities of chemical waste were known to be dumped at this location.

Experimental

The sampling strategy surrounding the disposal site incorporated upwind, downwind and crosswind sampling as well as on the dump mound itself, in order to ascertain which organic vapors were emanating from the landfill itself. Figure 8 depicts the sampling locations surrounding the Kin-Buc landfill in Edison, NJ. Table 15 gives the sampling protocol for investigating this site. The ambient air samples were collected according to the previously described procedure. (2,3)

Collected samples were submitted to glc/ms/comp analysis for either nitrosoamines or complete organic vapor characterization. The analytical protocol for this analysis has also been previously described. (3)

Results and Discussion

No nitrosoamines were detected in all samples examined. The identity of the compounds in samples obtained from upwind and downwind positions as well as on top of the chemical dump are listed in Tables 26-33 (Appendix I). After comparing the results obtained for each of the samples surrounding the chemical dump site, compounds were selected for quantification based on their presence only in samples obtained either on the mound or downwind from the chemical dump site or their extraordinarily high concentrations in ambient air. The concentration of several organic vapors are given in Table 16. Very high concentrations of benzene, dichloromethane, toluene, vinyl methyl ether, vinyl isopropyl ether and methyl chloroform were observed. In addition to several chlorinated hydrocarbons, methylene bromide was identified. This represents the first case in which we have identified this compound in ambient air.

COMPOSITION OF AMBIENT AIR FROM LOS ANGELES, CA BASIN

Sampling was performed in the Los Angeles basin area at locations near major industrial sites. The primary type of industrial activity was the

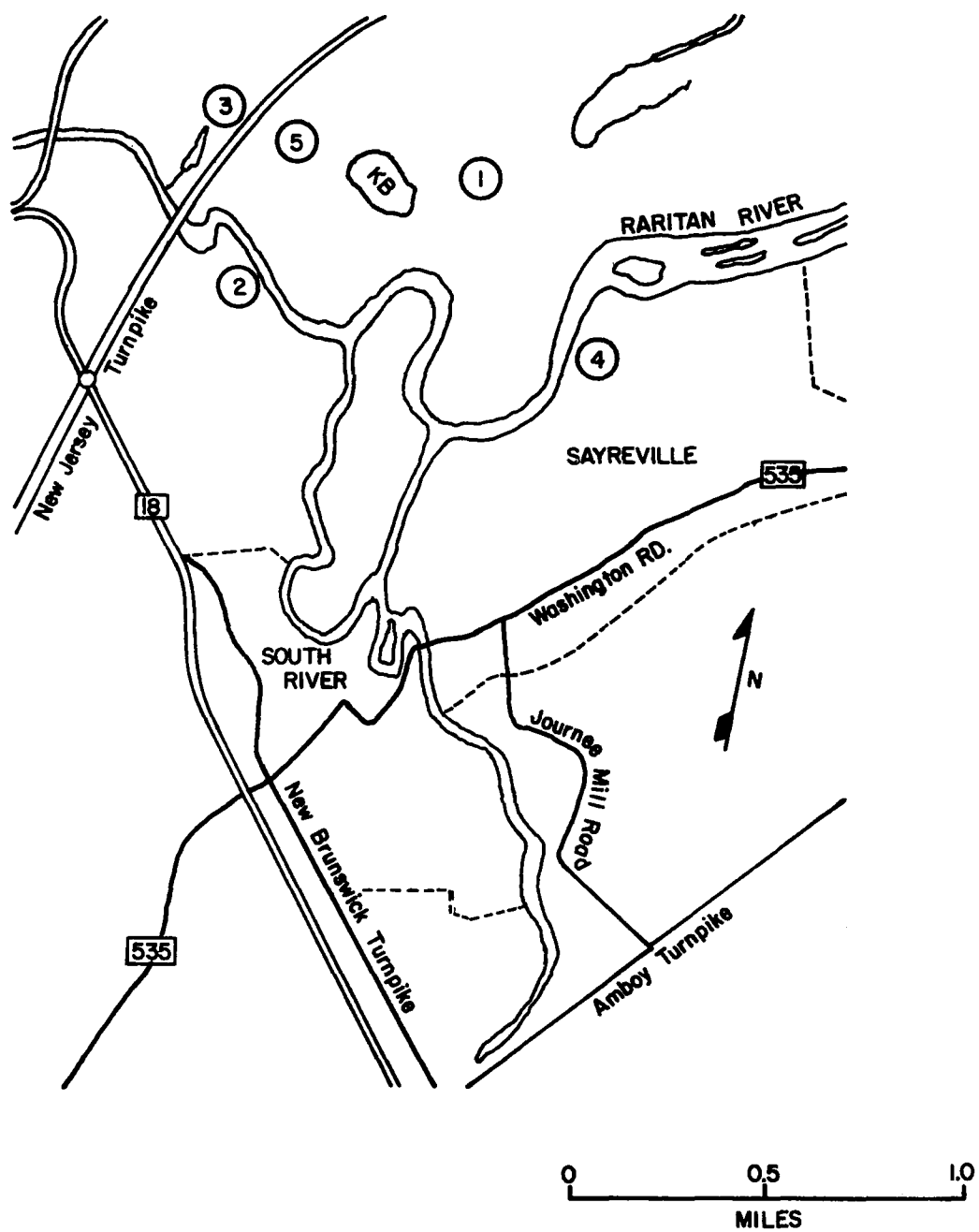


Figure 8. Sampling locations surrounding Kin-Buc Land-fill, Edison, NJ

Table 15. AMBIENT AIR SAMPLING PROTOCOL FOR INVESTIGATING CHEMICAL DUMP/LANDFILL IN EDISON, NJ

Sampling Period	Location (No.) ^a	Bearing°/distance ^b (mi)	Sampling Time (min)	m ³ /cartridge	Remarks
1	Parkland (1)	180-260/0.25	36	0.317	3/24/76 - 12:47 pm-1:23 pm 65°F 35% RH Clear 30.48" Hg Wind ~230°, 3-8 mph
2	Tower Marina (2) Schoolhouse Rd. East Brunswick, NJ	065-909/~1	38	0.300	3/24/76 - 4:47 pm-5:25 pm 64°F 38% RH Clear 30.42" Hg Wind 200-230°, 5-13 mph (upwind sample)
	Parkland (1)	180-260/0.25	38	0.290 0.032	As above (downwind samples)
3	Tower Marina (2)	065-090/~1	40	0.300	3/25/76 - 11:15 am-11:55 am 60°F 43% RH 3/4 Cloud 30.22" Hg Wind 225°, 3-8 mph (upwind sample)
	Parkland (1)	180-260/0.25	39	0.300	As above (downwind sample)
4	Tower Marina (2)	065-090/~1	45	0.300	3/25/76 - 3:08 pm-3:53 pm As above (upwind sample)
	Parkland (1)	160-275/~0.06	41	0.300	3/25/76 - 3:05 pm-3:46 pm As above (downwind sample)

(continued)

Table 15 (cont'd)

Sampling Period	Location (No.) ^a	Bearing°/distance ^b (mi)	Sampling Time (min)	m ³ /cartridge	Remarks
	Top of KB Mound	--	11	0.060 0.060	3/2576 - 3:06 pm-3:17 pm 64°F 38% RH Overcast 30.11" Hg Wind 265-285°, 5-10 mph
	Meadow Rd. (5) (between Stauffer and KB)	145°/0.5	42	0.300	3/25/76 - 4:20 pm-5:02 pm 63°F 45% RH 9/10 Cloudy 30.14" Hg Wind 245°, 2-8 mph (upwind sample)
5	NJ Turnpike (3) at Mill Rd.	140°/~0.75	130	0.914	3/26/76 - 10:48 am-12:59 pm 60°F 34% RH Clear 30.41" Hg Wind 300-320°, 0-10 mph Shifting to 230° at 12:45 pm (upfield sample)
	Sayreville, NJ (4) at St. Stanislaus School Rd.	315-325/1.25	130	0.958 0.117	3/26/76 - 10:49 am-12:59 pm As above (downwind sample)

^aSee map (Fig. 6) for location number.

^bRelative to dump site.

Table 16. CONCENTRATION OF ORGANIC VAPORS SURROUNDING KIN-BUC DUMP AREA

Compound	Location/Sampling Period								
	TM/2 (UW)	TM/3 (UW)	TM/4 (UW)	TP/5 (UW)	ST/5 (UW)	M/4 -	PL/1 (DW)	SA/5 (DW)	PL/2 (DW)
Acetaldehyde	249	trace	trace	ND	trace	trace	trace	trace	trace
Benzene	200	trace	0.90	trace	15	900	1,550	10	1,210
Bromoethane	ND	ND	ND	ND	ND	trace	1	ND	ND
Benzaldehyde	3	trace	trace	trace	trace	ND	ND	56	10
Carbon tetrachloride	20	trace	ND	trace	trace	ND	ND	trace	trace
Chloroform	trace	15	20	trace	45	266	74	30	128
1-Chloro-2-bromoethane	ND	ND	ND	ND	ND	27	25	ND	5
Chlorobenzene	trace	trace	trace	trace	trace	trace	50	4	trace
Dichloromethane	125	0.05	0.01	15	trace	1,250	375	0.042	390
1,2-Dichloroethane	ND	ND	ND	ND	ND	57	35	ND	33
Dibromomethane	ND	ND	ND	ND	ND	63	ND	ND	ND
Diethyl ether	ND	ND	ND	35	ND	30	23	ND	25
Diisopropyl ether	ND	ND	ND	ND	ND	120	17	ND	ND
Dimethyl naphthalene isomers	100	-	-	20	trace	trace	~6,100	trace	trace
Ethyl acetate	ND	ND	ND	ND	ND	trace	20	ND	ND
4-methyl-2-pentanone	ND	ND	ND	trace	ND	260	813	trace	33
Methyl n-propyl ether	ND	ND	ND	ND	-	trace	ND	ND	ND
Phenol	trace	trace	8	10	trace	ND	ND	trace	ND

(continued)

Table 16 (cont'd)

Compound	Location/Sampling Period								
	TM/2 (UW)	TM/3 (UW)	TM/4 (UW)	TP/5 (UW)	ST/5 (UW)	M/4 -	PL/1 (DW)	SA/5 (DW)	PL/2 (DW)
Toluene	-	-	-	-	972	50	2,600	1500	1,500
Trichloroethylene	9	trace	ND	trace	13	trace	93	trace	82
1,1,1-Trichloroethane	trace	0.03	ND	0.04	trace	500	25	0.03	5
Tetrachloroethylene	trace	trace	trace	8	trace	142	trace	60	26
Vinyl methyl ether	ND	ND	ND	ND	trace	5,000	ND	ND	ND
Vinyl isopropyl ether	ND	ND	ND	ND	trace	13,000	ND	ND	ND

^aValues are in $\mu\text{g}/\text{m}^3$.

^bTM = Tower Marina, UW = upwind, TP = NJ Turnpike, M = mound, PL = Parkland, SA = Sayreville, ST = Stauffer and DW = downwind

synthesis, storage and usage of organic chemicals. Because of these types of activities sampling was performed near this industrial area in order to ascertain whether emissions might occur of volatile organic compounds which may have health effect implications.

Experimental

The sampling and analytical methods employed in this study were as described earlier. The sampling protocol is listed in Table 17 and their locations are given in Figures 9-11. In the first case, sampling was conducted at 15th and Emery Street in Los Angeles, which was a location downwind from a chemical company and in the second case a location at 2055 203rd Street. The second location was also downwind from an industrial chemical area.

Results and Discussion

Tables 34-36 list the organic pollutants vapors which were identified at the locations given in Table 17. The ambient air sample from the 15th and Emery Street location contained several halogenated compounds of interest. These were: methyl chloride, ethyl chloride, carbon tetrachloride, trichloroethylene. Two esters were also identified: isobutyl acetate and n-butyl acetate. In a second sample taken from this location, mono vinyl glycol ether. An ambient air sample from Dominguez, CA contained several halogenated compounds. These were methyl chloride, ethyl chloride, 1,1,-dichloroethane, 1,2-dichloroethane, 1,1,1-trichloroethane, carbon tetrachloride, trichloroethylene, 1,1,2-trichloroethane and trichlorobenzene. Generally these chlorinated compounds are not ubiquitous. Other halogenated hydrocarbons were also detected, however these have occurred in many ambient air samples analyzed from several different geographical areas around the Continental U.S.

The concentrations of selected organic volatile pollutants in ambient air samples from the Los Angeles Basin area are also given in Table 34-36.

Table 17. AMBIENT AIR SAMPLING PROTOCOL FOR LOS ANGELES, CA BASIN AREA

Sampling Location	Bearing°/distance (yd)	Sampling Time (min)	m ³ /cartridge	Remarks
15th & Emery St. Los Angeles, CA	215-240°/~350	52	0.300	5/14/76 - 3:34 pm - 4:24 pm 83°F 42% RH Clear 29.92" Hg Wind-215° @ 0-7 mph
2055 223 St. Dominquez, CA	090-140°/~350 (Stauffer) 170°/165 (Witco)	54	0.300	5/14/76 - 1:22 pm - 2:16 pm 78° 49% RH Clear 30.11"Hg Wind-110-140° @ 0-7 mph

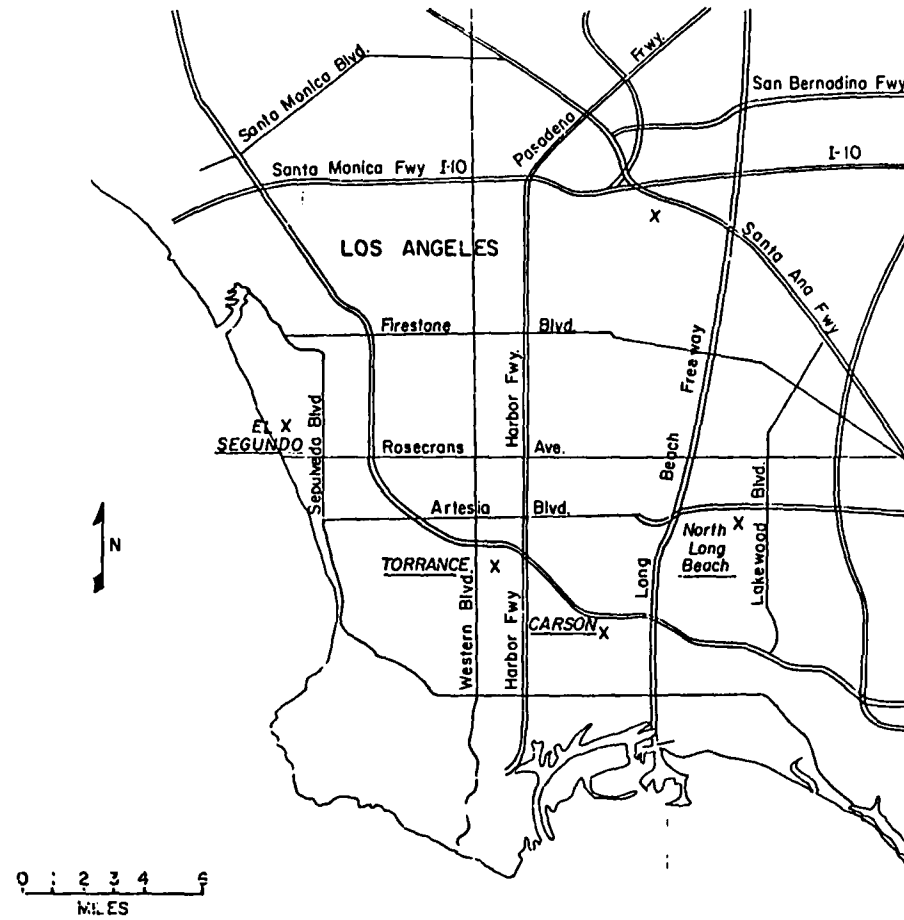


Figure 9. Map depicting sampling locations in Los Angeles, CA

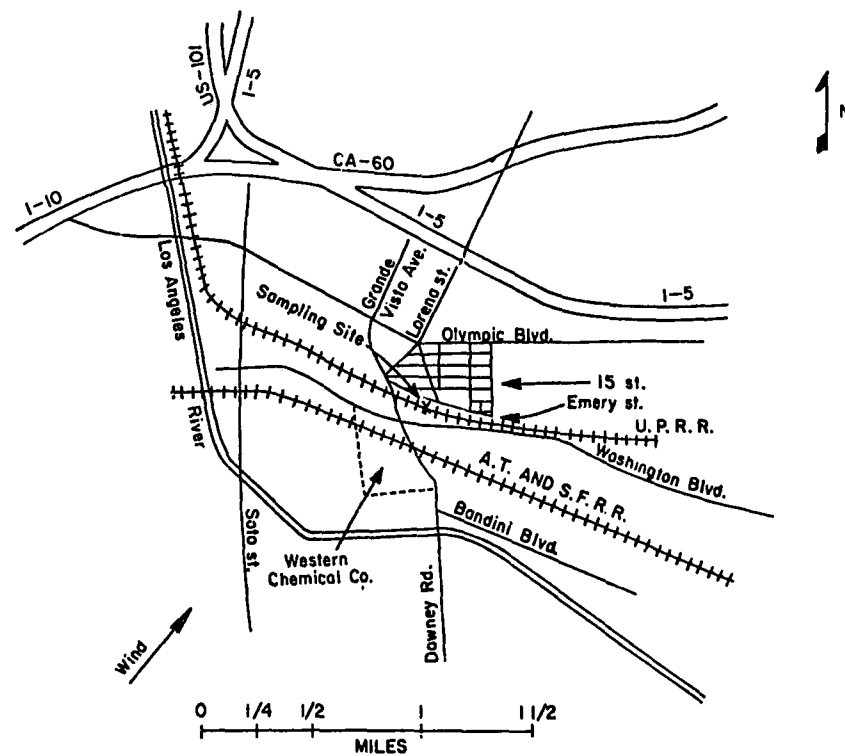


Figure 10. Map depicting sampling site in Los Angeles, CA

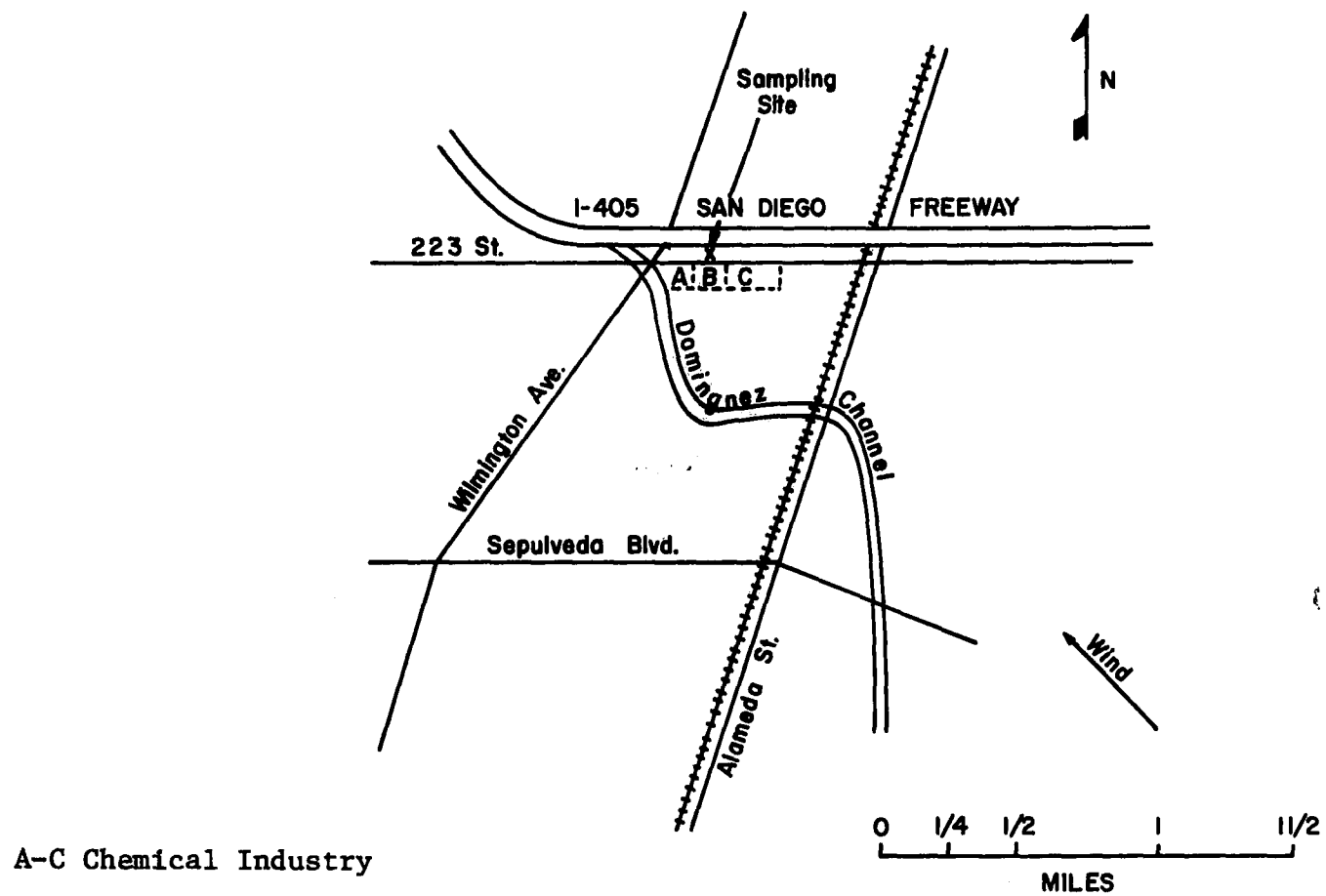


Figure 11. Map depicting sampling location in Dominquez, CA

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APPENDIX A
VOLATILE ORGANICS IDENTIFIED AND QUANTIFIED IN AMBIENT AIR

Table 18. VOLATILE ORGANIC VAPORS IDENTIFIED IN AMBIENT AIR
FROM BALTIMORE, MD^a

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound
	73	trichlorofluoromethane	38	167	isopropylbenzene
1	75	C ₅ H ₁₂ isomer	39	170	C ₁₀ H ₂₂ isomer
2	80	methylene chloride	40	171	C ₉ H ₁₈ isomer
3	89	trimethylsilanol (BKG)	41	172	trichloropropane isomer (tent.)
4	96	unknown	42	173	trichlorobutane isomer (tent.)
5	98	chloroform	43	174	C ₃ -alkyl benzene
6	99	1-chloro-2-methylpropene	43A	174	C ₁₀ H ₂₂ isomer
7	101	3-chloro-2-methylpropene	44	176	C ₃ -alkyl benzene
8	103	C ₅ H ₁₆ isomer	45	178	C ₃ -alkyl benzene
9	106	1,1,1-trichloroethane	46	180	C ₁₀ H ₂₂ isomer
10	110	benzene	47	181	n-decane
10A	110	carbon tetrachloride	47A	181	C ₃ -alkyl benzene
11	111	C ₅ H ₁₆ isomer	48	185	m-dichlorobenzene
12	113	C ₇ H ₁₆ isomer	49	186	C ₁₁ H ₂₄ isomer
13	114	C ₇ H ₁₆ isomer	49A	186	C ₄ -alkyl benzene
14	116	hexamethyldisiloxane	50	187	C ₃ -alkyl benzene
15	118	dibromomethane	51	188	C ₄ -alkyl benzene
15A	118	trichloroethylene	52	190	o-dichlorobenzene
16	119	C ₇ H ₁₆ isomer	52A	190	C ₉ H ₁₀ isomer
16A	119	C ₇ H ₁₄ isomer	53	191	C ₄ -alkyl benzene
17	124	C ₈ H ₁₈ isomer	53A	191	trimethylphenoxysilane
18	126	C ₇ H ₁₄ isomer	54	191	C ₄ -alkyl benzene
19	127	1,1-dichloro-2-methylpropane (tent.)	55	192	C ₄ -alkyl benzene
20	129	C ₈ H ₁₈ isomer	56	193	C ₁₁ H ₂₄ isomer
21	131	C ₈ H ₁₆ isomer	57	194	C ₃ -alkyl benzene
22	132	2,3-dichlorobutane (racemic)	58	196	C ₄ -alkyl benzene
23	134	toluene	59	197	C ₄ -alkyl benzene
23A	135	C ₈ H ₁₈ isomer	60	198	C ₁₀ H ₁₂ isomer
24	136	2,3-dichlorobutane (meso)	61	199	n-undecane
25	138	C ₈ H ₁₆ isomer	62	201	methylene dioxytoluene isomer (tent.)
25A	140	C ₈ H ₁₈ isomer	63	202	C ₅ -alkyl benzene
26	142	n-octane	64	204	C ₄ -alkyl benzene
26A	142	n-nitrosodimethylamine	65	205	C ₅ -alkyl benzene
27	144	tetrachloroethylene	66	207	C ₅ -alkyl benzene
28	146	dichlorobutene isomer	66A	207	C ₁₁ H ₂₂ isomer
29	149	1,3-dichloro-2-methylene pro- pane (tent.)	66B	208	C ₁₂ H ₂₆ isomer
30	151	chlorobenzene	67	208	C ₁₂ H ₂₆ isomer
31	155	ethylbenzene	69	210	C ₁₀ H ₁₂ isomer
32	156	p-xylene	70	211	C ₅ -alkyl benzene
33	158	dibromochlorofluoromethane	71	212	C ₅ -alkyl benzene
34	160	styrene	72	213	t-butylcyclohexane
35	162	o-xylene	73	214	C ₆ -alkyl benzene
36	163	n-nonane	74	215	trichlorobenzene isomer
37	166	C ₁₀ H ₂₂ isomer	75	216	n-dodecane

(continued)

Table 18 (cont'd)

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound
76	217	naphthalene			
77	218	C ₁₃ H ₂₈ isomer			
78	220	C ₆ -alkyl benzene isomer			
79	225	C ₆ -alkyl benzene isomer			
80	226	C ₁₃ H ₂₆ isomer			
81	228	C ₁₃ H ₂₆ isomer			
82	230	C ₁₃ H ₂₈ isomer			
83	230	<u>n</u> -tridecane			

^a Ambient air sampled at site 1 (Fig. 1) on 10/14/75 from 1100-1450 hr (Table 10).

Table 19. VOLATILE ORGANIC VAPORS IDENTIFIED IN AMBIENT AIR
FROM BALTIMORE, MD^a

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound
5	73	chloroethane	47	169	isopropylbenzene
5A	74	trichlorofluoromethane	48	171	C ₁₀ H ₂₂ isomer
6	77	n-pentane	49	172	C ₉ H ₁₈ isomer
6A	83	C ₅ H ₁₀ isomer	50	173	cyclohexanone (tent.)
6B	85	methylene chloride	51	175	n-propylbenzene
6C	88	acetone	52	176	m-ethyltoluene
7	92	trimethylsilanol	53	177	p-ethyltoluene
8	95	C ₆ H ₁₄ isomer	54	178	1,3,5-trimethylbenzene
9	98	C ₆ H ₁₄ isomer	56	179	C ₁₀ H ₂₀ isomer
10	100	chloroform	57	180	1,2,4-trimethylbenzene
12	105	C ₆ H ₁₂ isomer	57A	180	o-ethyltoluene
12A	108	1,1,1-trichloroethane	58	183	n-decane
12B	109	C ₇ H ₁₆ isomer	59	185	C ₄ -alkyl benzene
13	112	benzene	60	186	C ₄ -alkyl benzene
14	114	C ₇ H ₁₆ isomer	61	187	C ₁₁ H ₂₄ isomer
15	115	C ₇ H ₁₆ isomer	62	189	1,2,3-trimethylbenzene
16	116	C ₇ H ₁₆ isomer	63	190	C ₁₁ H ₂₄ isomer
17	118	hexamethyldisiloxane	64	191	m-dichlorobenzene
19	121	C ₇ H ₁₆ isomer	65	191.5	C ₁₀ H ₂₀ isomer
20	126	C ₈ H ₁₆ isomer	66	192	trimethylphenoxysilane
21	128	dimethylpentene isomer	68	193	C ₄ -alkyl benzene
22	129	C ₇ H ₁₄ isomer	69	194	C ₄ -alkyl benzene
23	130	C ₇ H ₁₆ isomer	70	196	acetophenone
24	131	C ₈ H ₁₆ isomer	71	198	C ₄ -alkyl benzene
25	134	hexanol isomer	72	198	C ₄ -alkyl benzene
26	136	toluene	73	199	C ₁₀ H ₁₂ isomer
27	138	C ₈ H ₁₈ isomer	74	201	n-undecane
28	141	C ₈ H ₁₆ isomer	75	203	C ₁₁ H ₂₂ isomer
30	143	n-octane	76	204	C ₁₂ H ₂₆ isomer
31	145	m/e 74 (DMN) trace	77	205	C ₄ -alkyl benzene
32	146	tetrachloroethylene	78A	206	C ₄ -alkyl benzene
33	148	C ₉ H ₂₀ isomer	79	207	3,4-dimethoxyacetophenone
34	149	C ₉ H ₂₀ isomer	80	208	C ₅ -alkyl benzene
35	150	C ₉ H ₂₀ isomer	81	210	C ₁₁ H ₂₂ isomer
36	151	C ₈ H ₁₆ isomer	83	211	C ₁₂ H ₂₆ isomer
37	153	chlorobenzene	84	211	C ₁₂ H ₂₆ isomer
38	154	C ₉ H ₁₈ isomer	85	213	C ₁₀ H ₁₂ isomer
39	156	ethylbenzene	86	215	C ₅ -alkyl benzene
40	157	C ₉ H ₂₀ isomer	87	216	C ₅ -alkyl benzene
41	158	p-xylene	89	217	C ₆ -alkyl benzene
41A	160	dibromochloromethane	90	217.5	n-dodecane
42	162	styrene	91	220	naphthalene
43	163	o-styrene	92	221	C ₁₃ H ₂₈ isomer
44	164	n-nonane	93	222	C ₆ -alkyl benzene
45	166	C ₁₀ H ₂₀ isomer	94	224	C ₁₃ H ₂₈ isomer
46	168	C ₉ H ₁₈ isomer	95	225	C ₆ -alkyl benzene

(continued)

Table 19 (cont'd)

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound
96	228	C ₁₄ H ₃₀ isomer			
97	230	C ₁₃ H ₂₆ isomer			
98	230	<u>n</u> -tridecane			

^a Ambient air sampled at Site 2 (Fig. 1), Patapsco Sewage Treatment Plant on 10/16/76 from 1000-1350 hr, see Table 10 for sampling protocol.

Table 20. VOLATILE ORGANIC VAPORS IDENTIFIED IN AMBIENT AIR
FROM BALTIMORE, MD^a

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound
1	53	<u>n</u> -propane	36	134	toluene
2	56	SO ₂	37	137	C ₈ H ₁₈ isomer
3	59	C ₄ H ₁₀ isomer	37A	138	2,3-dichlorobutane (meso)
3A	60	chloroethane	38	140	C ₈ H ₁₆ isomer
3B	62	2-methylpropane	39	142	C ₈ H ₁₈ isomer
4	63	<u>n</u> -butane	40	143	<u>n</u> -octane
4A	64	2-butene	41	144	C ₈ H ₁₆ isomer
5	72	isopentane	42	145	tetrachloroethylene
5A	73	CFC1 ₃	43	147	C ₉ H ₂₀ isomer
6	75	C ₅ H ₁₀ isomer	44	148	C ₉ H ₂₀ isomer
7	76	<u>n</u> -pentane	45	149	C ₉ H ₂₀ isomer
8	78	C ₅ H ₁₀ isomer	46	150	C ₉ H ₁₈ isomer
9	80	C ₅ H ₁₀ isomer	47	151	C ₉ H ₂₀ isomer
10	81	methylene chloride	48	152	chlorobenzene
10A	82	acetone	49	156	ethylbenzene
11	87	isopropanol	50	157	<u>m</u> , <u>p</u> -xylene
11A	87	<u>t</u> -butanol	51	160	C ₉ H ₂₀ isomer
12	88	C ₆ H ₁₂ isomer	52	161	cyclooctatetraene
13	90	trimethylsilanol (BKG)	53	162	<u>o</u> -xylene
14	94	3-methylpentane	54	163	<u>n</u> -nonane
15	95	C ₆ H ₁₂ isomer	55	165	C ₉ H ₁₈ isomer
16	97	<u>n</u> -hexane	56	166	C ₉ H ₁₈ isomer
16A	98	2-methyl-3-butyne-2-ol (tent.)	57	168	C ₉ H ₁₈ isomer
17	99	chloroform	58	169	isopropylbenzene
18	101	1-chloro-2-methylpropene	59	170	C ₁₀ H ₂₂ isomer
19	103	3-chloro-2-methylpropene	60	171	C ₁₀ H ₂₂ isomer
20	105	methylcyclopentane	61	172	C ₉ H ₁₈ isomer
21	107	2-butanone	62	173	1,4-dichloro-2-butene
21A	107	1,1,1-trichloroethane	62A	173	1,2,3-trichloropropane (tent.)
22	110	C ₆ H ₁₀ isomer	62B	173	1,1,3,3-tetrachloro-2-methyl- propane (tent.)
23	111	benzene	63	174	<u>n</u> -propylbenzene
23A	111	CCl ₄	64	175	benzaldehyde
24	113	cyclohexane	65	176	<u>m</u> -ethyltoluene
24A	113	2,3-dimethylpentane	66	177	1,3,5-trimethylbenzene
25	116	C ₇ H ₁₆ isomer	67	178	C ₁₀ H ₂₀ isomer
26	117	C ₇ H ₁₄ isomer	68	179	<u>o</u> -ethyltoluene
27	119	trichloroethylene	69	182	1,2,4-trimethylbenzene
28	120	<u>n</u> -heptane	69A	182	<u>n</u> -decane
29	123	C ₇ H ₁₄ isomer	70	184	C ₁₀ H ₂₀ isomer
30	124	C ₇ H ₁₄ isomer	71	185	<u>m</u> -dichlorobenzene
31	126	C ₈ H ₁₈ isomer	72	186	C ₄ -alkyl benzene isomer
32	128	C ₇ H ₁₄ isomer	73	188	1,2,3-trimethylbenzene
33	129	C ₇ H ₁₄ isomer	74	189	limonene
34	131	C ₈ H ₁₈ isomer	75	190	<u>o</u> -dichlorobenzene
35	133	C ₈ H ₁₈ isomer	76	190	C ₉ H ₁₀ isomer
35A	134	2,3-dichlorobutane (rac.)			

(continued)

Table 20 (cont'd)

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound
77	191	C ₄ -alkyl benzene isomer			
78	192	C ₄ -alkyl benzene isomer			
79	193	C ₄ -alkyl benzene isomer			
80	194	C ₁₁ H ₂₄ isomer			
81	195	C ₄ -alkyl benzene isomer			
82	197	C ₄ -alkyl benzene isomer			
83	198	C ₁₀ H ₁₈ isomer			
84	199	C ₄ -alkyl benzene isomer			
85	200	n-undecane			
86	201	C ₁₁ H ₂₂ isomer			
87	202	C ₁₁ H ₂₂ isomer			
88	203	C ₅ -alkyl benzene isomer			
89	204	C ₄ -alkyl benzene isomer			
90	205	C ₄ -alkyl benzene isomer			
91	207	C ₅ -alkyl benzene isomer			
92	209	C ₁₀ H ₁₂ isomer			
93	210	C ₁₁ H ₂₂ isomer			
94	211	C ₅ -alkyl benzene isomer			
95	211	C ₅ -alkyl benzene isomer			
96	212	C ₅ -alkyl benzene isomer			
97	213	C ₅ -alkyl benzene isomer			
98	214	C ₅ -alkyl benzene isomer			
99	215	C ₆ -alkyl benzene isomer			
100	217	n-dodecane			
101	218	naphthalene			
102	220	C ₆ -alkyl benzene isomer			
103	220	C ₆ -alkyl benzene isomer			
isothermal					
104		Bkd			
105		Bkd			
107	220	Bkd			
isothermal					
108		Bkd			
109		Bkd			
110		Bkd			
111		Bkd			
112		Bkd			

^a Ambient air sampled at Site 1 (Fig. 1) on 10/14/76 from 2300-0250 hr, see Table 10 for sampling protocol.

Table 21. VOLATILE ORGANIC VAPORS IDENTIFIED IN AMBIENT AIR
FROM BALTIMORE, MD^a

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound
1	67	acetaldehyde	31	137	trimethylcyclopentane isomer
2	73	isopentane	32	138	C ₉ H ₁₈ isomer and trimethylcyclo- pentane isomer
2A	75	C ₅ H ₁₀ isomer	33	141	toluene
2B	76	furan	33A	142	C ₈ H ₁₈ isomer
2C	76	C ₅ H ₁₀ isomer	34	143	C ₈ H ₁₈ isomer
2D	77	n-pentane	35	146	C ₈ H ₁₆ isomer
3	78	acetone	35A	148	C ₈ H ₁₆ isomer
5	82	dichloromethane	36	149	n-octane
6	86	carbon disulphide	36A	150	N-nitrosodimethylamine (trace)
7	92	2-methylpentane	36B	151	C ₈ H ₁₆ isomer
8	96	3-methylpentane	37	152	tetrachloroethylene
9	97	C ₆ H ₁₂ isomer	37A	152	C ₈ H ₁₆ isomer
10	99	n-hexane	37B	153	C ₉ H ₁₈ isomer
10A	100	C ₆ H ₁₂ isomer	38	154	C ₉ H ₂₀ isomer
11	101	chloroform	39	155	C ₉ H ₂₀ isomer
12	103	C ₇ H ₁₆ isomer	40	156	C ₉ H ₂₀ isomer
12A	104	3-methylfuran	40A	157	C ₉ H ₁₈ isomer
13	105	C ₇ H ₁₆ isomer	41	158	C ₉ H ₂₀ isomer
14	106	C ₇ H ₁₆ isomer	42	159	ethylcyclohexane + C ₉ H ₁₈ isomer
15	107	methylcyclopentane	42A	159	chlorobenzene
15A	108	C ₇ H ₁₆ isomer	43	160	C ₉ H ₁₈ isomer
16	109	cyclohexadiene or C ₆ H ₁₀ isomer	43A	162	C ₉ H ₂₀ isomer
16A	110	1,1,1-trichloroethane	43B	163	C ₉ H ₁₈ isomer
17	113	hexadiene isomer	44	164	ethylbenzene
18	114	benzene	45	165	p-xylene
18A	115	CCl ₄	46	167	m-xylene
19	117	2-methylhexane and cyclohexane	46A	168	C ₉ H ₁₈ isomer
20	118	2,3-dimethylpentane	47	169	styrene
21	119	3-methylhexane	48	170	o-xylene
21A	120	C ₇ H ₁₄ isomer	49	171	n-nonane
22	122	dimethylcyclopentane isomer	50	172	C ₉ H ₁₈ isomer
23	123	C ₇ H ₁₆ isomer	50A	173	C ₁₀ H ₂₂ isomer
23A	124	trichloroethylene	50B	175	C ₁₀ H ₂₂ isomer
24	125	n-heptane	51	176	C ₁₀ H ₂₀ isomer
25	126	C ₇ H ₁₄ isomer	52	177	isopropylbenzene + C ₁₀ H ₂₂ isomer
25A	126	C ₇ H ₁₂ isomer	53	179	C ₁₀ H ₂₂ isomer
25B	128	C ₇ H ₁₄ isomer	54	180	C ₁₀ H ₂₀ isomer
26	129	C ₈ H ₁₆ isomer	55	181	C ₁₀ H ₂₀ isomer
26A	130	C ₈ H ₁₈ isomer	56	183	n-propylbenzene
27	131	C ₈ H ₁₈ isomer	56A	183	C ₁₀ H ₂₂ isomer
27A	132	C ₈ H ₁₆ isomer	57	184	m-ethyltoluene
28	132	methylcyclohexane	58	185	C ₁₀ H ₂₂ isomer
28A	133	C ₈ H ₁₆ isomer	58A	187	C ₁₀ H ₂₂ isomer
29	134	C ₈ H ₁₈ isomer			
29A	135	C ₈ H ₁₈ isomer			
30	136	C ₈ H ₁₆ isomer			

(continued)

Table 21 (cont'd)

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound
59	188	C ₁₁ H ₂₄ isomer			
59A	190	C ₁₀ H ₂₀ isomer			
60	191	1,2,4-trimethylbenzene + n-decane			
61	192	C ₁₁ H ₂₄ isomer			
62	193	C ₁₁ H ₂₄ isomer			
62A	194	C ₁₁ H ₂₂ isomer			
63	195	C ₁₁ H ₂₄ isomer			
64	196	C ₁₁ H ₂₂ isomer			
65	197	C ₁₁ H ₂₄ isomer			
66	199	C ₁₂ H ₂₆ isomer			
67	201	C ₁₂ H ₂₆ isomer			
68	204	C ₁₁ H ₂₄ isomer			

^a Ambient air was sampled 15 ft from dimazine facility at Site 1 (Fig. 1) on 11/19/75 from 1400-1600 hr, see Table 10 for sampling protocol.

Table 22. VOLATILE ORGANIC VAPORS IDENTIFIED IN AMBIENT AIR
FROM BALTIMORE, MD^a

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound
1	58	CO ₂	32	136	trimethylcyclopentane
1A	65	1-butene	33	137	C ₈ H ₁₆ isomer
2	66	n-butane	33A	138	C ₈ H ₁₈ isomer
2A	67	2-butene	33B	139	C ₈ H ₁₈ isomer
3	72	acetaldehyde	34	140	toluene
3A	74	C ₅ H ₁₀ isomer	34A	140	C ₈ H ₁₈ isomer
4	76	isopentane	35	142	C ₈ H ₁₈ isomer
5	77	C ₅ H ₁₀ isomer + furan	36	145	C ₈ H ₁₆ isomer
5A	79	C ₅ H ₁₀ isomer	37	148	n-octane
6	80	n-pentane	37A	149	N-nitrosodimethylamine (trace)
7	81	acetone	37B	149	C ₈ H ₁₆ isomer
8	84	dichloromethane	38	151	tetrachloroethylene
9	88	carbon disulphide	39	152	C ₉ H ₁₈ isomer
10	94	methyl ethyl ketone	40	153	C ₉ H ₂₀ isomer
11	98	2-methylpentane	41	154	C ₉ H ₂₀ isomer
12	99	C ₆ H ₁₂ isomer	42	156	C ₉ H ₂₀ isomer
13	101	n-hexane	43	157	C ₉ H ₂₀ isomer
14	103	chloroform	43A	158	C ₉ H ₁₈ isomer
15	105	C ₇ H ₁₆ isomer	44	159	chlorobenzene
16	106	C ₆ H ₁₂ isomer	44A	160	C ₉ H ₁₈ isomer
16A	108	pentanone isomer	45	161	ethylbenzene
17	109	methylcyclopentane	46	163	p-xylene
17A	111	methylcyclopentadiene	47	166	C ₉ H ₂₀ isomer
18	112	1,1,1-trichloroethane	48	167	cyclooctatetraene
19	114	C ₆ H ₁₀ isomer	49	168	m-xylene
20	115	benzene	49A	169	C ₉ H ₁₈ isomer
20A	116	carbon tetrachloride	50	170	o-xylene
21	117	2-methylhexane	51	174	C ₁₀ H ₂₂ isomer
22	118	cyclohexane	52	175	isopropylbenzene
23	119	3-methylhexane	53	176	C ₁₀ H ₂₀ isomer
23A	121	C ₇ H ₁₆ isomer	53A	177	C ₁₀ H ₂₂ isomer
24	122	dimethylcyclopentane isomer	54	178	C ₁₀ H ₂₀ isomer
24A	122	2-pentanone	55	179	C ₁₀ H ₁₆ isomer
25	123	C ₇ H ₁₆ isomer	56	180	n-propylbenzene
25A	123	3-pentanone (tent.)	57	181	m-ethyltoluene
26	124	trichloroethylene	58	183	C ₁₀ H ₂₂ isomer
26A	125	n-heptane	59	185	C ₁₀ H ₂₂ isomer
26B	126	C ₇ H ₁₄ isomer	60	186	C ₁₀ H ₂₂ isomer
26C	127	C ₇ H ₁₂ isomer	60A	187	α-methylstyrene and C ₁₀ H ₂₀ isomer
27	128	C ₇ H ₁₄ isomer	61	188	1,2,4-trimethylbenzene
27A	129	C ₈ H ₁₈ isomer	62	189	C ₁₀ H ₂₂ isomer or n-decane
28	130	methylpentanone isomer and C ₈ H ₁₈ isomer	62A	189	C ₁₁ H ₂₄ isomer
29	132	methylcyclohexane	63	190	m-dichlorobenzene
30	133	C ₈ H ₁₆ isomer	64	192	C ₁₁ H ₂₄ isomer
31	134	C ₈ H ₁₆ isomer			

(continued)

Table 22 (cont'd)

Chromatographic Peak No.	Elution Temp. (°C)	Compound	Chromatographic Peak No.	Elution Temp. (°C)	Compound
65	193	C ₁₁ H ₂₄ isomer and 1,2,3-trimethylbenzene			
66	194	C ₁₁ H ₂₄ isomer			
67	196	C ₁₁ H ₂₂ isomer			
67A	197	indane			
68	198	C ₁₁ H ₂₄ isomer and indene and sec-butylbenzene			
69	199	isobutylbenzene and o-cymene			
70	200	C ₁₁ H ₂₄ isomer			
71	202	C ₁₁ H ₂₄ isomer			
71A	203	C ₄ -alkyl benzene isomer			
72	204	C ₁₁ H ₂₂ isomer			
73	205	C ₁₁ H ₂₄ isomer			
73A	205	C ₄ -alkyl benzene isomer			
73B	206	ethylstyrene isomer and C ₁₀ H ₂₂ isomer			
74	207	C ₁₁ H ₂₄ isomer			
75	208	C ₁₂ H ₂₆ isomer			
77	211	C ₁₂ H ₂₆ isomer			
78A	215	C ₁₂ H ₂₄ isomer			
79	217	C ₁₂ H ₂₆ isomer			
80	219	C ₁₂ H ₂₆ isomer			

^a Ambient air was sampled near dimazine facility at Site 1 (Fig. 1) on 11/24/75 from 1355-1555 hr, see Table 10 for sampling protocol.

Table 23. VOLATILE ORGANIC VAPORS IDENTIFIED IN AMBIENT AIR
FROM BELLE, WV^a

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	ug/m ³	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	ug/m ³
1	63	CF ₂ Cl ₂		42	156	C ₅ H ₁₁ OH isomer	
2	66	chloromethane		42A	157	C ₆ H ₁₂ O isomer	
3	68	n-propane		43	160	C ₈ H ₁₂ isomer	
4	68	vinyl chloride	~2-4,000	44	162	ethylbenzene	
4A	68	dimethyl ether		45	163	C ₉ H ₂₀ isomer	
5	68	acetaldehyde	~9,800	46	164	p-xylene	
6	74	n-butane		47	166	C ₉ H ₂₀ isomer	
7	81	isopentane		48	168	cyclooctatetraene	
8	82	acetone		48A	168	styrene	
8A	83	trichlorofluoromethane		49	169	o-xylene	
9	86	diethyl ether		50	170	n-nonane	
10	90	methylene chloride	8,700	51	174	C ₉ H ₁₈ isomer	
11	101	trimethyl silanol		52	175	isopropylbenzene	
12	104	3-methylpentane		53	177	C ₁₀ H ₂₀ isomer	
13	106	n-butanol		54	179	C ₉ H ₁₈ isomer	
13A	107	3,3-dimethyl-2-butanol		55	180	C ₉ H ₁₈ isomer	
14	108	n-hexane		56	180	C ₉ H ₁₈ isomer	
14A	109	CHCl ₃		57	182	m-ethyltoluene	
15	114	C ₇ H ₁₆ isomer		57A	182	benzaldehyde	
16	116	C ₆ H ₁₂ isomer		58	184	p-ethyltoluene	
17	118	1,1,1-trichloroethane		59	185	hexyl methacrylate	
18	118	C ₇ H ₁₆ isomer		60	186	C ₃ -alkyl benzene isomer	
19	120	m/e 73		61	189	o-ethyltoluene	
20	122	benzene	~400,000	62	190	n-decane	
21	124	C ₇ H ₁₆ isomer		63	191	C ₁₀ H ₂₀ isomer	
21A	124	CCl ₄		64	192	m-dichlorobenzene	
22	126	cyclohexane		65	194	C ₁₁ H ₂₄ isomer	
23	126	silane compound (BKG)		66	195	C ₃ -alkyl benzene isomer	
24	127	silane compound (BKG)		67	196	C ₁₁ H ₂₄ isomer	
25	129	C ₇ H ₁₄ isomer		68	199	C ₄ -alkyl benzene isomer	
26	130	trichloroethylene		69	201	C ₄ -alkyl benzene isomer	
27	131	methyl methacrylate		70	202	acetophenone	
28	136	C ₈ H ₁₈ isomer		71	203	C ₁₁ H ₂₄ isomer	
29	138	C ₇ H ₁₄ isomer		72	204	C ₄ -alkyl benzene isomer	
30	139	C ₈ H ₁₈ isomer		73	206	C ₄ -alkyl benzene isomer	
31	140	C ₇ H ₁₄ isomer		74	208	n-undecane	
32	141	C ₈ H ₁₆ isomer		75	209	C ₁₂ H ₂₆ isomer	
33	142	C ₈ H ₁₆ isomer		76	210	C ₁₂ H ₂₆ isomer	
34	145	toluene		77	211	C ₄ -alkyl benzene isomer	
35	146	C ₈ H ₁₈ isomer		78	213	C ₄ -alkyl benzene isomer	
36	147	C ₈ H ₁₈ isomer		79	214	C ₅ -alkyl benzene isomer	
37	148	dimethyl formamide	~76,700	80	214	C ₅ -alkyl benzene isomer	
38	150	C ₈ H ₁₆ isomer		81	214	C ₁₂ H ₂₆ isomer	
39	151	n-octane		82	215	C ₁₀ H ₁₂ isomer	
40	152	tetrachloroethylene		83	215	C ₅ -alkyl benzene isomer	
41	154	C ₉ H ₂₀ isomer		84	215	C ₁₂ H ₂₄ isomer	

(continued)

Table 23 (cont'd)

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	µg/m ³	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	µg/m ³
85	216	C ₁₂ H ₂₄ isomer					
86	216	n-dodecane					
87	217	naphthalene					
88	220	C ₆ -alkyl benzene isomer					
89	220	n-tridecane					

^a Ambient air was sampled at location No. 8, see Table 13 for protocol.

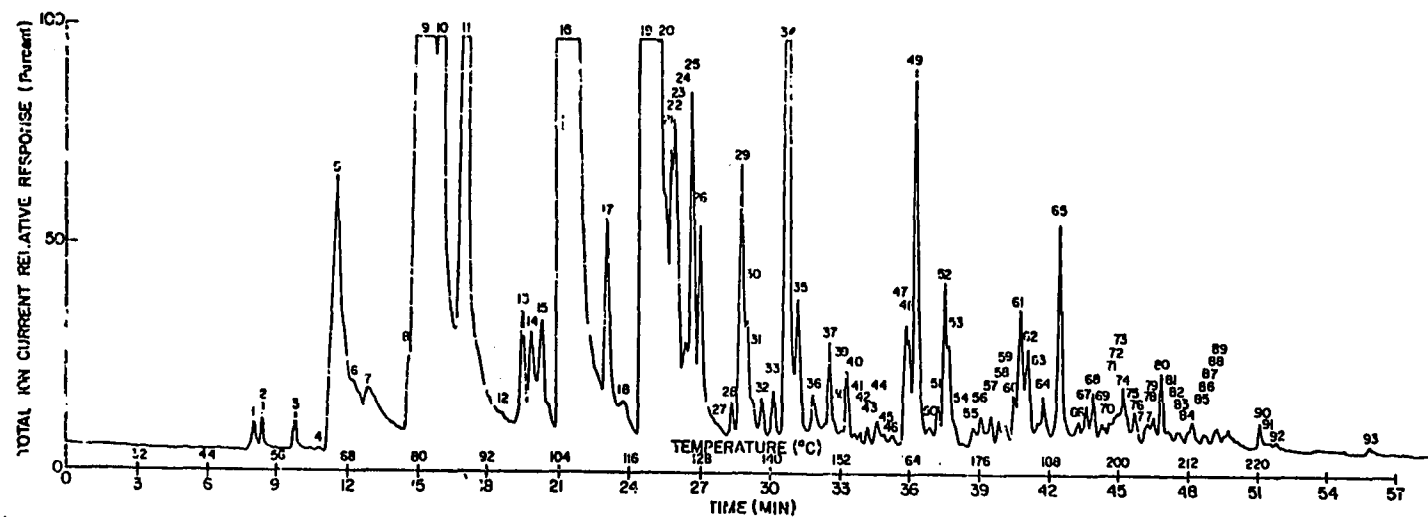


Figure 12. Total ion current profile of ambient air sample taken at location no. 9 on Union Carbide property. See Tables 13 and 24 for protocol and listing, respectively.

Table 24. VOLATILE ORGANIC VAPORS IN AMBIENT AIR
FROM SOUTH CHARLESTON, WV^a

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	ng/m ³	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	ng/m ³
1	52	N ₂ + O ₂		42	155	C ₉ H ₁₈ isomer	
2	54	CO ₂		43	156	C ₉ H ₂₀ isomer	
3	63	propane		44	158	C ₉ H ₁₈ isomer	
4	65	vinyl chloride	trace	45	160	C ₈ H ₁₆ isomer	
5	65	acetaldehyde		46	161	C ₈ H ₁₆ isomer	
6	69	n-butane		47	163	ethylbenzene	
7	71	methyl amine (tent.)		48	164	C ₉ H ₂₀ isomer	
8	78	isopentane		49	165	p-xylene	
9	79	dimethyl ether		50	167	C ₉ H ₂₀ isomer	
9A	80	propanal	>~200,000	51	169	styrene	
9B	80	acetone		52	170	o-xylene	
10	83	diethyl ether		53	170	n-nonane	
11	87	methylene chloride		54	172	C ₉ H ₁₈ isomer	
12	95	C ₆ H ₁₄ isomer		55	175	C ₉ H ₁₈ isomer	
13A	98	C ₆ H ₁₄ isomer		56	176	cumene	
14	99	γ-butyrolactone (tent.)	3,750	57	178	C ₁₀ H ₂₂ isomer	
15	101	3-methylpentane		58	180	C ₁₀ H ₂₀ isomer	
16A	104	n-hexane		59	181	alpha-pinene	
16B	105	chloroform	>~175,000	60	182	n-propylbenzene	
16C	106	ethyl acetate		61	183	m-ethyltoluene	
17	112	C ₆ H ₁₂ isomer		62	184	1,3,5-trimethylbenzene	
18	115	1,1,1-trichloroethane		63	186	C ₁₀ H ₂₂ isomer	
19A	119	benzene	>~200,000	64	187	o-ethyltoluene	
19B	119	carbon tetrachloride		65A	190	1,2,4-trimethylbenzene	
19C	120	cyclohexane		65B	190	n-decane	
20	122	C ₇ H ₁₆ isomer		66	193	m-dichlorobenzene	
21	123	C ₇ H ₁₆ isomer		67	194	C ₄ -alkyl benzene isomer	
22	123	C ₇ H ₁₆ isomer		68	195	1,2,3-trimethylbenzene	
24	125	C ₇ H ₁₄ isomer		69	196	C ₁₁ H ₂₄ isomer	
25	126	trichloroethylene		70	197	C ₁₁ H ₂₂ isomer	
26	128	n-heptane		71	198	C ₁₀ H ₂₀ isomer	
27	131	C ₈ H ₁₈ isomer		72	199	C ₄ -alkyl benzene isomer	
28	134	C ₈ H ₁₈ isomer		73	200	C ₄ -alkyl benzene isomer	
29	135	C ₇ H ₁₄ isomer		74	201	C ₄ -alkyl benzene isomer	
30	136	C ₈ H ₁₈ isomer		75	202	C ₄ -alkyl benzene isomer	
31	137	C ₈ H ₁₆ isomer		76	203	C ₁₁ H ₂₄ isomer	
32	138	C ₈ H ₁₆ isomer		77	205	C ₄ -alkyl benzene isomer	
33	140	C ₈ H ₁₆ isomer		78	206	C ₁₀ H ₁₈ isomer	
34	142	toluene		79	207	C ₁₀ H ₁₂ isomer	
35	144	C ₈ H ₁₈ isomer		80	208	n-undecane	
36	147	C ₈ H ₁₆ isomer		81	209	C ₅ -alkyl benzene isomer	
37	150	n-octane		82	211	C ₁₂ H ₂₆ isomer	
38	151	C ₈ H ₁₆ isomer		83	212	C ₄ -alkyl benzene isomer	
39	152	C ₉ H ₂₀ isomer		84	213	C ₄ -alkyl benzene isomer	
40	153	tetrachloroethylene		85	214	C ₄ -alkyl benzene isomer	
41	154	C ₉ H ₂₀ isomer		86	215	C ₅ -alkyl benzene isomer	

(continued)

Table 24 (cont'd)

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	ng/m ³	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	ng/m ³
87	217	C ₅ -alkyl benzene isomer					
88	219	C ₁₀ H ₁₂ isomer (tent.)					
89	220	C ₅ -alkyl benzene isomer					
90	220	n-dodecane					
91	220	C ₁₁ H ₁₄ isomer					
92	220	C ₅ -alkyl benzene isomer					
93	220	n-tridecane					

^a Ambient air sampling was at location No. 9, see Table 13 for protocol.

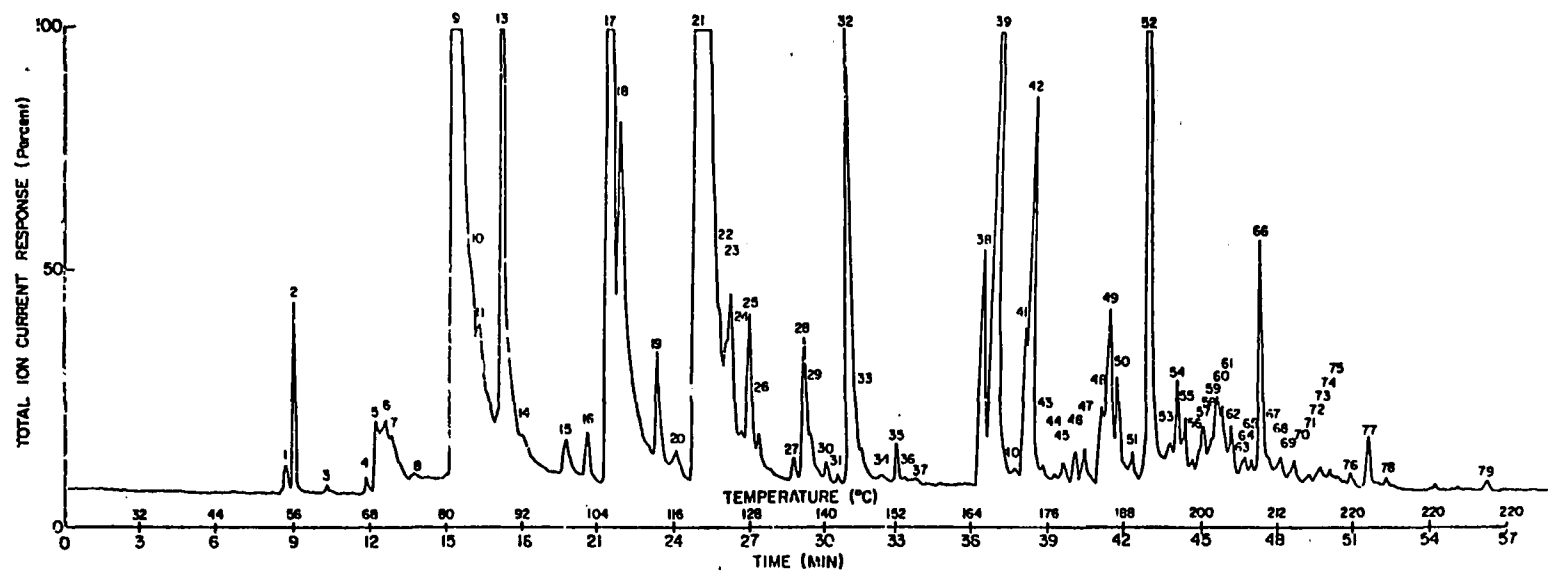


Figure 13. Total ion current profile of ambient air taken at Interstate 60 and WV 25 in Nitro, WV. See Table 13 and 25 for protocol and listings, respectively.

Table 25. VOLATILE ORGANIC VAPORS IDENTIFIED IN AMBIENT AIR
FROM NITRO, WV^a

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	ng/m ³	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	ng/m ³
1	55	N ₂		39	167	p-xylene	
2	56	CO ₂		40	170	C ₉ H ₁₈ isomer	
3	62	SO ₂		41	172	o-xylene	
3C	64	chloromethane		42	173	n-nonane	
3D	65	propane		43	175	anisole	
4A	68	vinyl chloride	~50,000	44	176	C ₁₀ H ₂₂ isomer	
4B	68	2-methylpropene		45	178	cumene	
5	69	acetaldehyde		46	180	C ₁₀ H ₂₂ isomer	
6	70	n-butane		47A	181	C ₉ H ₁₈ isomer	
7	71	2-butene		47B	181	C ₁₀ H ₂₀ isomer	
8	75	C ₅ H ₁₀ isomer		48A	181	C ₉ H ₁₈ isomer	
9	79	isopentane		48B	184	benzaldehyde	
9C	82	acetone	>~125,000	49A	185	C ₃ -alkyl benzene isomer	
10	84	C ₅ H ₁₂ isomer		49B	185	C ₁₀ H ₂₂ isomer	
11	85	diethyl ether		50	187	C ₃ -alkyl benzene isomer	
12	86	propanal		51	189	C ₃ -alkyl benzene isomer	
13	89	methylene chloride	>~75,000	52A	192	C ₃ -alkyl benzene isomer	
14	92	carbon disulphide		52B	192	n-decane	
15A	100	C ₆ H ₁₄ isomer		53	195	m-dichlorobenzene	
16	103	3-methylpentane		54	196	C ₄ -alkyl benzene isomer	
17	106	n-hexane		55	197	C ₃ -alkyl benzene isomer	
18A	108	chloroform	~39,000	56	198	C ₁₁ H ₁₄ isomer	
18B	111	ethyl acetate		57	200	o-dichlorobenzene	
19	113	C ₆ H ₁₂ isomer		58	200	C ₁₀ H ₂₀ isomer	
20	116	1,1,1-trichloroethane		59	202	C ₄ -alkyl benzene isomer	
21A	120	benzene	>~150,000	60	203	C ₄ -alkyl benzene isomer	
21B	123	cyclohexane		61	204	C ₄ -alkyl benzene isomer	
22	124	C ₇ H ₁₆ isomer		62	205	C ₁₁ H ₂₄ isomer	
23	125	C ₇ H ₁₆ isomer		63	207	C ₄ -alkyl benzene isomer	
24	127	C ₇ H ₁₆ isomer		64	207	C ₄ -alkyl benzene isomer	
25A	128	C ₇ H ₁₆ isomer		65	208	C ₄ -alkyl benzene isomer	
25B	128	trichloroethylene		66	209	n-undecane	
26	129	n-heptane		67	211	C ₅ -alkyl benzene isomer	
27	135	C ₈ H ₁₈ isomer		68	212	C ₅ -alkyl benzene isomer	
28	137	C ₇ H ₁₄ isomer		69	215	C ₄ -alkyl benzene isomer	
29	138	C ₇ H ₁₄ isomer		70	215	C ₄ -alkyl benzene isomer	
30	140	C ₈ H ₁₆ isomer		71	217	C ₅ -alkyl benzene isomer	
31	142	C ₈ H ₁₈ isomer		72	218	C ₅ -alkyl benzene isomer	
32	145	toluene		73	220	C ₁₂ H ₂₆ isomer	
33	146	C ₈ H ₁₆ isomer		74	isothermal	C ₁₀ H ₁₂ isomer	
34	149	C ₈ H ₁₆ isomer		75		C ₁₂ H ₂₆ isomer	
35	152	C ₈ H ₁₈ isomer		76		1,2,3,4-tetrahydronaphthalene	
36	153	C ₈ H ₁₆ isomer		77A		n-dodecane	
37A	155	tetrachloroethylene		77B		naphthalene	
37B	160	chlorobenzene		78		C ₁₃ H ₂₈ isomer	
38	165	ethylbenzene		79		n-tridecane	

^a Ambient air sampling was at location No. 15, see Table 13 for protocol.

Table 26. VOLATILE ORGANIC VAPORS IDENTIFIED IN AMBIENT AIR NEAR
KIN-BUC CHEMICAL DISPOSAL SITE, EAST BRUNSWICK, NEW JERSEY^a

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	µg/m ³	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	µg/m ³
	59	CO ₂		32	164	chlorobenzene	
1	64-6	difluorodichloromethane		33	167-8	ethylbenzene	
2	68	n-propane		34	168-9	p-xylene	
3	72	1-butene		35	172-3	styrene	
3A	73	n-butane		36	173-5	n-nonane and o-xylene	
4	78-82	acetaldehyde	249	36A	177	C ₁₀ H ₂₀ isomer	
5	84	isopentane		37	179	isopropylbenzene	
6	86	trichlorofluoromethane		38	181	C ₁₀ H ₂₂ isomer	
7	89	n-pentane		39	185	n-propylbenzene	
7A	90	C ₅ H ₁₀ isomer		40	186	m-ethyltoluene	
8	93	dichloromethane	125	40A	187	C ₁₀ H ₂₂ isomer	
9	96	C ₆ H ₁₄ isomer		41	188-192	benzaldehyde and phenol	3
10	104	2-methylpentane		42	189	silane compound	
10A	104	3-methylpentane			190	o-ethyltoluene	
11	107	C ₆ H ₁₂ isomer		42A	191	C ₁₁ H ₂₂ isomer	
	108-110	diethyl ether		43	191	1-decene	
12	108-111	perfluorobenzene (e#)		44	192-3	n-decane and 1,2,4-trimethyl- benzene	
12A	110	n-hexane		45	196	C ₁₁ H ₂₂ isomer	
	108-120	ethanol		46	198	C ₄ -alkyl benzene isomer	
13	112-113	chloroform		47	203	C ₁₁ H ₂₂ isomer	
14	115-116	perfluorotoluene (e#)			205	C ₄ -alkyl benzene isomer	
	118	methylcyclopentane		48	206-8	acetophenone	
15	120	C ₅ H ₁₀ O isomer		49	210	n-undecane	
16	123	1,1,1-trichloroethane		52	217	C ₄ -alkyl benzene isomer	
17	124-5	benzene	200	53	219	silane compound	
17A	125	CCl ₄	20	54	221	ethyl phenol isomer	
17B	126	cyclohexane		55	225	n-dodecane	
18	128	C ₇ H ₁₆ isomer		56	227	naphthalene	
18A	129	allyl acetate (tent.)		57	230	methyl ethyl phenol isomer	
18B	130	C ₇ H ₁₄ isomer		58	232	4-isopropylphenol	
19	132	C ₇ H ₁₆ isomer and trichloro- ethylene	9	59	235	C ₄ -alkyl phenol isomer	
20	133	n-heptane		60	236	methyl-1,2-dihydronaphthalene isomer	
21	135	C ₅ H ₁₀ O isomer		61	239	C ₁₃ H ₂₆ isomer	
22	138	C ₈ H ₁₈ isomer		62	240	n-tridecane	
23	140	methylcyclohexane		62A	240	C ₄ -alkyl phenol	
24	143	C ₈ H ₁₆ isomer		63	240	β-methylnaphthalene	
25	145	C ₈ H ₁₈ isomer		64	240	α-methylnaphthalene	
26	148	toluene		67	240	n-tetradecane and biphenyl	
27	149	C ₈ H ₁₈ isomer		68	240	ethylnaphthalene isomer	
28	152	C ₈ H ₁₆ isomer		69	240	dimethylnaphthalene isomer	100
28A	153	methyl isobutyl ketone		70	240	dimethylnaphthalene isomer	
29	154	n-octane		71	240	dimethylnaphthalene isomer	
30	156-7	hexamethylcyclotrisiloxane		72	240	dimethylnaphthalene isomer	
30A	157-8	tetrachloroethylene		73	240	n-pentadecane	
31	158	C ₉ H ₂₀ isomer					

(continued)

Table 26 (cont'd)

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	µg/m ³	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	µg/m ³
74	240	6-phenylfulene (tent.)					

^a Ambient air was sampled during period No. 2, location No. 2, see Table 15 for protocol.

Table 27. VOLATILE ORGANIC VAPORS IDENTIFIED IN AMBIENT AIR
NEAR KIN-BUC DISPOSAL SITE^a

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	g/m ³	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	g/m ³
1	64	difluorodichloromethane		33	172	cyclooctatetraene or styrene	
2	72	1-butene		34	174	<u>o</u> -xylene and <u>n</u> -nonane	
2A	73	<u>n</u> -butane		35	177	silane compound	
4	78-82	acetaldehyde		36	180	isopropylbenzene	
4A	84	isopentane		37	181	C ₁₀ H ₂₂ isomer	
5	86	trichlorofluoromethane		38	183	C ₃ -alkyl cyclohexane isomer	
5A	88	furan (tent.) and C ₅ H ₁₀ isomer		39	186	<u>n</u> -propylbenzene	
6	89	<u>n</u> -pentane		40	187	<u>m</u> -ethyltoluene	
7	92	propanal (tent.)		41	189	benzaldehyde and phenol and silane compound	
8	94	dichloromethane	0.05	42	193-3	1,2,4-trimethylbenzene and <u>n</u> - decane	
8A	97	C ₆ H ₁₄ isomer and methyl- disilane		43	194	C ₁₁ H ₂₄ isomer	
9	100	C ₆ H ₁₂ isomer		44	196	dichlorobenzene (<u>m</u> or <u>p</u>)	
10	104	2-methylpentane		45	198	1,2,3-trimethylbenzene	
11	108	3-methylpentane		46	201	<u>o</u> -dichlorobenzene	
12	110	hexafluorobenzene and <u>n</u> -hexane		46A	202	C ₁₁ H ₂₂ isomer	
13	113	chloroform	15	47	203	C ₄ -alkyl benzene isomer	
13A	114	diethyl ether		48	205	C ₁₁ H ₂₄ isomer	
14	116	perfluorotoluene (e ₃)		49	208	acetophenone	
15	121	1,1,1-trichloroethane	0.03	50	210	<u>n</u> -undecane	
16	125	benzene and carbon tetra- chloride		51	213	C ₁₂ H ₂₆ isomer	
17	126	C ₇ H ₁₆ isomer and cyclohexane		52	215	C ₄ -alkyl benzene isomer	
18	128	3-methylhexane		53	217	silane compound	
18A	130	allyl acetate (tent.)	trace	54	219	C ₁₂ H ₂₄ isomer	
19	131	C ₇ H ₁₆ isomer		55	221	C ₁₂ H ₂₆ isomer	
20	133	trichloroethylene and <u>n</u> - heptane		55A	224	C ₁₂ H ₂₄ isomer	
21	140	methyl cyclohexane		56	226	<u>n</u> -dodecane	
22	144	C ₈ H ₁₈ isomer		57	228	naphthalene	
23	145	C ₈ H ₁₆ isomer		57A	229	C ₁₁ H ₁₄ isomer	
24	148	toluene		58	230	dimethyl aniline (tent.)	
25	150	C ₈ H ₁₆ isomer		59	234	C ₁₃ H ₂₈ isomer	
26	152	C ₈ H ₁₆ isomer and <u>n</u> -butyl acetate (tent.)		60	237	C ₆ -alkyl benzene isomer	
26A	153	2-hexanone		62	240	C ₁₃ H ₂₆ isomer	
27	153	<u>n</u> -octane		63	240	<u>n</u> -tridecane	
28	156-7	hexamethylcyclotrisiloxane and tetrachloroethylene	trace	64	240	β -methylnaphthalene	
28A	159	C ₉ H ₁₈ isomer		65	240	α -methylnaphthalene	
28B	161	C ₉ H ₂₀ isomer		67	240	C ₁₄ H ₂₀ isomer	
28C	163	C ₉ H ₁₈ isomer		68	240	<u>n</u> -tetradecane and biphenyl	
29	165	chlorobenzene		69	240	ethylnaphthalene isomer	
30	168	ethylbenzene		70	240	dimethylnaphthalene isomer	
31	169	<u>p</u> -xylene		71	240	dimethylnaphthalene isomer	
32	170	C ₉ H ₂₀ isomer		72	240	dimethylnaphthalene isomer	
				73	240	biphenylene	
				74	240	<u>n</u> -pentadecane	

^a Ambient air was sampled during period No. 4, location 2, see Table 15 for protocol.

Table 28. VOLATILE ORGANIC VAPORS IDENTIFIED IN AMBIENT AIR
NEAR KIN-BUC DISPOSAL SITE^a

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	µg/m ³	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	µg/m ³
1	64	dichlorodifluoromethane		40	194	m or p-dichlorobenzene and ter-butylbenzene	
2	73	1-butene		41	196	1,2,3-trimethylbenzene	
3	75	n-butane		42	199	methyl styrene isomer and sec- butylbenzene	
4	81	acetaldehyde		43	200	o-cymene	
5	84	isopentane		44	201	n-butylbenzene	
6	87	trichlorofluoromethane		45	201	C ₁₁ H ₂₄ isomer	
7	89	n-pentane and furan		46	203	p-propyltoluene	
8	94	dichloromethane	0.01	47	203-5	acetophenone and C ₄ -alkyl benzene isomer	
10	104	2-methylpentane		48	206	methyl indan isomer	
11	107	3-methylpentane		49	207	n-undecane	
12	110	hexafluorobenzene and n-hexane		50	208	C ₅ -alkyl benzene isomer	
13	113	chloroform	20	50A	209	C ₁₂ H ₂₆ isomer	
14	116	perfluorotoluene (eS)		51	210	C ₄ -alkyl benzene isomer	
15	121	1,1,1-trichloroethane	0.05	52	212	C ₅ -alkyl benzene isomer	
16	125	benzene	0.90	53	215	C ₅ -alkyl benzene isomer	
16A	126	cyclohexane and C ₇ H ₁₅ isomer		53A	216	C ₅ -alkyl cyclohexane isomer	
17	128	3-methylhexane		54	217	methyl indan isomer	
18	131	C ₇ H ₁₄ isomer		54A	217	C ₁₂ H ₂₄ isomer	
19	132	n-heptane		55	219	C ₅ -alkyl benzene isomer and C ₄ -alkyl benzene isomer	
19A	135	C ₅ H ₁₀ O isomer		56	221	C ₁₂ H ₂₄ isomer and C ₅ -alkyl benzene isomer	
20	140	methylcyclohexane		56A	222	C ₆ -alkyl benzene	
20A	143	n-propyl acetate (tent.)	trace	57	224	n-dodecane	
21	147	toluene		57A	225	dimethyl indan isomer	
21A	148	C ₈ H ₁₈ isomer		58	226	naphthalene	
21B	151	C ₈ H ₁₆ isomer		59	229	C ₅ -alkyl benzene and C ₁₃ H ₂₈ isomer	
22	153	n-octane		59A	230	C ₆ -alkyl benzene isomer	
23	155	hexamethylcyclotrisiloxane and tetrachloroethylene		60	232	C ₁₃ H ₂₆ isomer	
24	160	C ₉ H ₂₀ isomer		61	234	C ₁₃ H ₂₆ isomer and C ₃ -alkyl indan isomer	
25	164	chlorobenzene		61A	235	C ₁₁ H ₁₆ isomer	
26	166	ethylbenzene		62	237	C ₁₃ H ₂₈ isomer	
27	167	p-xylene		63	240	C ₁₃ H ₂₆ isomer	
28	169	C ₉ H ₁₈ isomer		63A	240	C ₃ -alkyl indan isomer	
29	171	styrene		64	240	n-tridecane	
30	172	o-xylene and n-nonane		66	240	β-methylnaphthalene	
31	175	C ₁₀ H ₂₂ isomer		67	240	α-methylnaphthalene	
32	178	isopropylbenzene		69	240	C ₁₄ H ₃₀ isomer	
33	181	C ₁₀ H ₂₂ isomer and C ₃ -alkyl cyclohexane		70	240	n-tetradecane	
34	184	n-propylbenzene					
35	185	m-ethyltoluene					
36	186	benzaldehyde					
37	187	silane compound					
38	188	phenol	~8				
39	190	1,2,4-trimethylbenzene and n- decane					

^a Ambient air was sampled during period No. 3, location No. 2, see Table 15 for protocol.

Table 29. VOLATILE ORGANIC VAPORS IDENTIFIED IN AMBIENT AIR
NEAR KIN-BUC DISPOSAL SITE^a

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	ug/m ³	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	ug/m ³
1	68	dichlorodifluoromethane		37	177	<u>o</u> -xylene and <u>n</u> -nonane	
2	72	SO ₂		38	182	C ₁₀ H ₂₂ isomer	
2A	74	propane		39	184	isopropylbenzene	
3	76	1-butene		40	185	<u>n</u> -propylbenzene	
3A	77	<u>n</u> -butane		41	188	<u>o</u> -chlorotoluene	47
4	80-6	acetaldehyde		42	189	<u>p</u> -ethyltoluene	
5	88	isopentane		43	190	benzaldehyde	
6	90	trichlorofluoromethane		44	191	phenol	
7	92	C ₅ H ₁₀ isomer		45	193	<u>o</u> -ethyltoluene	
8	93	<u>n</u> -pentane		46	194-6	benzyl methyl ether	
8A	96	C ₆ H ₁₂ isomer		47	198	benzyl chloride	
9	98	dichloromethane	trace	50	206	C ₄ -alkyl benzene	
	99	C ₆ H ₁₄ isomer		51	208	2,3-dihydrobenzaldehyde or benzyl chloride	
10	100-3	3-methylpentane		52	210	acetophenone and C ₄ -alkyl benzene and C ₁₀ H ₂₀ isomer	
11	108	2-methylpentane		53	212	<u>n</u> -undecane and methyl benzoate	
12	111	C ₆ H ₁₂ isomer		54	217	dichlorotoluene isomer	
13	113	perfluorobenzene (e3)		55	218	silane compound	
14	114	<u>n</u> -hexane			223	dichlorotoluene isomer	
15	116-7	chloroform	45	56	227	<u>n</u> -dodecane	
16	120	perfluorotoluene (e3)		57	229	naphthalene	
	122	C ₆ H ₁₂ isomer		58	231-2	methyl toluate isomer	
17	124-6	1,1,1-trichloroethane	trace		240	methylnaphthalene isomer	
18	128	benzene	15				
18A	129	CCl ₄	trace				
19	130	cyclohexane and C ₇ H ₁₆ isomer					
	131	C ₇ H ₁₆ isomer					
20	132	C ₇ H ₁₄ isomer					
21A	134	C ₇ H ₁₆ isomer					
21	135	trichloroethylene	13				
22	137	<u>n</u> -heptane					
23	142	C ₈ H ₁₈ isomer					
24	144	methylcyclohexane					
25	147	C ₈ H ₁₆ isomer					
26	149	C ₈ H ₁₈ isomer					
27	150-4	toluene	972				
28	156	1-octene					
29	158	<u>n</u> -octane					
30	160	hexamethylcyclotrisiloxane					
31	161	tetrachloroethylene					
31A	164	methyl ethyl cyclopentane isomer					
32	168	chlorobenzene					
33	170	ethylbenzene					
34	172	<u>p</u> -xylene					
35	174	C ₈ H ₁₄ isomer					
36	176	styrene or cyclooctatetraene					

^a Ambient air was sampled during period no. 4, location no. 5, see Table 15 for protocol.

Table 30. VOLATILE ORGANIC VAPORS IDENTIFIED IN AMBIENT AIR
NEAR KIN-BUC DISPOSAL SITE^a

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	ug/m ³	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	ug/m ³
1	64	dichlorodifluoromethane		28	147-50	toluene	50
1A	73	1-butene		29	152	dimethylcyclohexane	
1B	74	<u>n</u> -butane		30	154	<u>n</u> -octane	
1C	75	2-butene		30A	155	hexamethylcyclotrisiloxane	
2	77	SO ₂		31	157	tetrachloroethylene	142
3	80	acetaldehyde		32	160	<u>n</u> -butyl acetate	
3A	84	isopentane		33	163	methylethylcyclopentane isomer	
4	86	trichlorofluoromethane		34	164	chlorobenzene	
4A	88	C ₅ H ₁₀ isomer		35	167	ethylbenzene	
5	89	<u>n</u> -pentane		36	168-9	<u>p</u> -xylene	
6	90-2	vinyl methyl ether	5,000	37	171	C ₉ H ₂₀ isomer	
6A	92	bromoethane		38	173	styrene	
7	92-6	dichloromethane	1,250	39	174	<u>o</u> -xylene and <u>n</u> -nonane	
7A	98	1,1,1-trifluoro-2,2,2- trichloroethane			176	C ₁₀ H ₂₂ isomer	
8	100	acetone			176	C ₁₀ H ₂₀ isomer	
9	101	diethyl ether	30	40	178	C ₁₀ H ₂₂ isomer	
9A	102	methyl <u>n</u> -propyl ether		41	180	isopropylbenzene	
10	104	2-methylpentane		42	181	C ₁₀ H ₂₂ isomer	
11	105-8	vinyl isopropyl ether and C ₆ H ₁₄ isomer	13,000 (ether)	43	183	<u>n</u> -propylcyclohexane	
12	109	perfluorobenzene (e ₂)		43A	184	C ₁₀ H ₂₂ isomer	
13	110-11	<u>n</u> -hexane		43B	185	C ₁₀ H ₂₀ isomer	
14	112-114	chloroform and diisopropyl ether	266 (CHCl ₃) +120 (ether)	44	186	<u>n</u> -propylbenzene	
15	116	perfluorotoluene (e ₂)		45	187-8	<u>m</u> -ethyltoluene and trimethyl- heptane isomer	
15A	117	methyl ethyl ketone		46	189	C ₁₀ H ₂₂ isomer and <u>o</u> -ethyl- toluene	
15B	117	C ₆ H ₁₂ isomer		47	190	C ₁₀ H ₂₂ isomer	
16	118	ethyl acetate		47A	192	C ₁₀ H ₂₀ isomer	
17	119	1,2-dichloroethane	57	48	193	<u>n</u> -decane and 1,2,4-trimethyl- benzene	
18	120	1,1,1-trichloroethane	500	48A	195	C ₁₁ H ₂₄ isomer	
19	124	benzene	900	49	197	C ₁₁ H ₂₄ isomer and C ₄ -alkyl benzene	
20	126	cyclohexane and C ₇ H ₁₆ isomer		50	198	1,2,3-trimethylbenzene and C ₁₁ H ₂₄ isomer	
21	128	3-methylheptane		52	202	C ₁₁ H ₂₄ isomer	
21A	129	isopropyl acetate		54	206	C ₁₂ H ₂₆ isomer	
21B	130	C ₇ H ₁₆ isomer		55	208	C ₄ -alkyl benzene isomer and acetophenone	
22	131	dibromomethane	63	56	210	C ₁₄ H ₃₀ isomer	
22A	132	trichloroethylene			240	naphthalene	
23	133	<u>n</u> -heptane					
24	134-6	ethyl acrylate					
25	137-8	1-chloro-2-bromoethane	27				
25A	139	methyl methacrylate					
26	140	methyl cyclohexane and <u>n</u> - propyl acetate					
27	141-4	4-methyl-2-pentanone	260				
27A	144-6	1,1,2-trichloroethane					

^a Ambient air was sampled during period no. 4, location on the mound, see Table 15 for protocol.

Table 31. VOLATILE ORGANIC VAPORS IN AMBIENT AIR
NEAR KIN-BUC DISPOSAL SITE^a

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	µg/m ³	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	µg/m ³
	59	CO ₂		32	152	C ₈ H ₁₆ isomer and 4-methyl-2-pentanone	
	60	cyclopropane		33	154	n-octane	
1	65	difluorodichloromethane		34	157	hexamethylcyclotrisiloxane	
3	70	propane		35	158	tetrachloroethylene	8
4	74	n-butane		36	161	C ₉ H ₂₀ isomer	
4A	75	2-butene		36A	163	C ₉ H ₁₈ isomer	
4B	77	chloroethane		37	165	chlorobenzene	trace
5	80	acetaldehyde		38	168	ethylbenzene	
5A	81	dichlorofluoromethane		39	169	p-xylene	
5B	83	acetone (tent.)		39A	171	C ₉ H ₁₈ isomer	
6	85	isopentane		40	173	cyclooctatetraene or styrene	
7	88	trichlorofluoromethane		41	174	o-xylene and n-nonane	
7A	89	C ₅ H ₁₀ isomer		41A	176	C ₁₀ H ₂₂ isomer	
8	90	n-pentane		42	180	isopropylbenzene	
8A	92	C ₅ H ₁₀ isomer		42A	181	C ₁₀ H ₂₂ isomer	
9	95	dichloromethane	15	43	183	C ₃ -alkyl cyclohexane isomer	
10	97	2,2-dimethylbutane			184	C ₁₀ H ₂₂ isomer	
11	100	C ₆ H ₁₄ isomer		44	186	n-propylbenzene	
12	104	2-methylpentane		45	187	m-ethyltoluene and C ₁₁ H ₂₄ isomer	
13	107	dimethyl ether		46	188	benzaldehyde	
14	108	3-methylpentane		47	190	phenol	-10
14A	109	C ₆ H ₁₂ isomer		47A	191	silane compound	
15	110	hexafluorobenzene (e3)		47B	192	1-decene	
16	111	n-hexane		48	193	1,2,4-trimethylbenzene and n-decane	
16A	112	diethyl ether	35	49	196	m or p-dichlorobenzene	
17	113	chloroform		49A	197	C ₄ -alkyl benzene isomer and C ₁₁ H ₂₄ isomer	
18	117	perfluorotoluene (e3)		50	198	1,2,3-trimethylbenzene	
19	119	C ₇ H ₁₄ isomer		50A	199	C ₁₁ H ₂₄ isomer	
19A	120	C ₇ H ₁₆ isomer		50B	200	o-dichlorobenzene	
20	121	1,1,1-trichloroethane	0.04	51	201	methyl styrene	
21	125	benzene		51A	202	C ₄ -alkyl benzene isomer	
21A	126	carbon tetrachloride	trace	52	204	C ₁₁ H ₂₄ isomer	
22	127	cyclohexane and C ₇ H ₁₆ isomer		53	206	acetophenone	
23	129	C ₇ H ₁₄ isomer		54	210	n-undecane	
24	131	C ₇ H ₁₄ isomer		54A	211	C ₁₀ H ₁₂ isomer	
25	132	1-heptane		55	212	C ₁₁ H ₂₂ isomer and C ₁₂ H ₂₆ isomer	
26	134	trichloroethylene and n-heptane		55A	213	C ₁₁ H ₂₀ isomer	
27	139	C ₈ H ₁₈ isomer		57	215	C ₄ -alkyl benzene	
28	141	methylcyclohexane		58	217	silane compound	
28A	142	C ₈ H ₁₆ isomer		60	221	C ₄ -alkyl benzene isomer and C ₅ -alkyl benzene isomer	
29	144	C ₈ H ₁₈ isomer					
30	146	C ₈ H ₁₆ isomer					
31	148	toluene					
31A	150	C ₈ H ₁₈ isomer					

(continued)

Table 31 (cont'd)

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	ug/m ³	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	ug/m ³
61	223	1-dodecane					
62	226	<u>n</u> -dodecane					
63	228	naphthalene					
67	240	1-tridecane					
68	240	<u>n</u> -tridecane					
69	240	β-methylnaphthalene					
70	240	α-methylnaphthalene					
72	240	biphenyl					
73	240	<u>n</u> -tetradecane					
74	240	ethylnaphthalene isomer					
75	240	dimethylnaphthalene isomer	-20				
76	240	dimethylnaphthalene isomer					
77	240	dimethylnaphthalene isomer					
78	240	biphenylene					

^a Ambient air sampled during period no. 5, location no. 3, see Table 15 for protocol.

Table 32. VOLATILE ORGANIC VAPORS IDENTIFIED IN AMBIENT AIR
NEAR KIN-BUC DISPOSAL SITE^a

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	µg/m ³	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	µg/m ³
1		difluorodichloromethane		33	179-80	C ₁₀ H ₂₂ isomer	
2		acetaldehyde		34	181-2	propylcyclohexane and C ₁₀ H ₂₀ isomer	
2A	83	isopentane		35	183-6	n-propylbenzene and chloro- toluene and m-ethyltoluene and C ₁₀ H ₂₂ isomer	29,700
3	85	trichlorofluoromethane		35A	186-8	C ₁₀ H ₂₀ isomer and silane compound	
4	88	n-pentane		35B	188-89	o-ethyltoluene and α-methyl styrene	
4A	91	C ₅ H ₁₀ isomer			190	C ₁₀ H ₂₀ isomer	
4B	92	bromoethane	1	36	190-93	n-decane and 1,2,4-trimethyl- benzene	
5	93-5	dichloromethane	375	37A	194	p-dichlorobenzene	
6	101-4	2-methylpentane		37	194-196	C ₁₁ H ₂₄ isomer and C ₄ -alkyl benzene	
7	105-108	3-methylpentane and diethyl ether	23	37A	196-7	1,2,3-trimethylbenzene	
8	108-110	perfluorobenzene and n-hexane		37B	197-8	C ₁₀ H ₁₆ isomer	
9	111	CHCl ₃	74	37C	198-200	o-dichlorobenzene	
10	113	diisopropyl ether	17		198-200	C ₄ -alkyl cyclohexane isomer and 8-methylstyrene and C ₄ -alkyl benzene and C ₁₁ H ₂₂ isomer	~69,000
11	114-5	perfluorotoluene (e ₃)		37D	200-2	C ₁₁ H ₂₄ isomer	
12	116	methylcyclopentane and n-butanal	30	37E	202-4	C ₄ -alkyl benzene isomer and C ₁₁ H ₂₄ isomer C ₄ -alkyl benzene	
13	118	ethyl acetate and 1,2- dichloroethane	20 + 35	38A	205-6	C ₁₀ H ₁₈ isomer	
14	119	1,1,1-trichloroethane	25		205-8	acetophenone	
15	122-4	benzene	1,550	38B	206	C ₁₀ H ₁₆ isomer and C ₁₁ H ₂₂ isomer and C ₄ -alkyl benzene	~12,840
16	125	2,3-dimethylpentane		38	207-8	n-undecane	
17	126-8	isopropyl acetate and C ₇ H ₁₆ isomer		38C	209-10	C ₅ -alkyl benzene isomer	
18	103-3	trichloroethylene and C ₇ H ₁₄ isomer and n-heptane		38D	211	C ₅ -alkyl cyclohexane isomer and C ₅ -alkyl benzene isomer and C ₁₂ H ₂₆ isomer	
19	133-4	2,5-dimethylfuran (tent.) and methyl methacrylate		39	212-14	C ₄ -alkyl benzene isomer	
20	135-6	1-chloro-2-bromoethane	25	40	215	C ₅ -alkyl benzene isomer and C ₁₁ H ₂₀ isomer	
21	137	C ₇ H ₁₄ isomer		41	216-7	C ₆ -alkyl benzene isomer	
22	138-144	4-methyl-2-pentanone	813	42	218-19	C ₅ -alkyl benzene isomer	
22A	144	1,1,2-trichloroethane	17	43	220-22	C ₆ -alkyl benzene isomer and C ₁₃ H ₂₈ isomer	
23	145-50	toluene	2,600	44	222-24	1,3,5-trichlorobenzene and n-dodecane	
24	151	C ₈ H ₁₆ isomer		45	225	naphthalene	
25	152-6	n-octane	15,000				
25A	155-8	tetrachloroethylene					
26	159	C ₉ H ₂₀ isomer					
27	160-1	C ₈ H ₁₈ isomer					
28	162-4	chlorobenzene	50				
29A	165-7	ethylbenzene					
29	167-70	C ₈ H ₁₈ O isomer and p-xylene					
30A	171-2	styrene					
30	172-6	o-xylene and n-nonane and C ₉ H ₁₈ isomer					
31	177	C ₁₀ H ₂₂ isomer					
32	178-9	isopropylbenzene					

(continued)

Table 32 (cont'd)

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	ug/m ³	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	ug/m ³
46	226	C ₁₃ H ₂₈ isomer and C ₁₁ H ₁₄ isomer					
47	228	1,2,4-trichlorobenzene					
48	232	C ₁₃ H ₂₆ isomer					
49	235	C ₁₁ H ₂₂ isomer					
50	237	tridecane					
51	239	n-tridecane					
	240	C ₁₂ H ₁₆ isomer					
52	240	β-methylnaphthalene	3,100				
53		α-methylnaphthalene	3,000				
54		C ₇ -alkyl benzene isomer					
55		C ₁₃ H ₁₈ isomer					
56		C ₁₄ H ₂₈ isomer					
57		n-tetradecane					
58		C ₁₃ H ₁₈ isomer					
59		C ₁₃ H ₁₈ isomer					
60		β-ethylnaphthalene					
61		α-ethylnaphthalene and C ₁₅ H ₃₀ isomer					

^a Ambient air sampled during period No. 1, location No. 1, see Table 15 for protocol.

Table 33. VOLATILE ORGANIC VAPORS IDENTIFIED IN AMBIENT AIR
NEAR KIN-BUC DISPOSAL SITE^a

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	ug/m ³	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	ug/m ³
1	64	dichlorodifluoromethane		37	181	C ₁₀ H ₂₂ isomer	
2	69	n-propane		38	183	C ₁₀ H ₂₀ isomer	
3	71	1-butene		39	185	n-propylbenzene	
4	73	n-butane		40	186	m-ethyltoluene and C ₁₀ H ₂₂ isomer	
6	81	acetaldehyde		41	188	benzaldehyde	56
7	85	isopentane		41A	189	silane compound (BKG)	
8	88	trichlorofluoromethane		42	189-90	phenol and o-ethyltoluene	
8A	90	furan		43	193	1,2,4-trimethylbenzene and n-decane	
8B	91	C ₅ H ₁₀ isomer		43A	193	C ₁₁ H ₂₄ isomer	
8C	92	n-pentane		44	194	C ₄ -alkyl benzene isomer	
9	96	C ₅ H ₁₀ isomer		45	197	1,2,3-trimethylbenzene and C ₁₁ H ₂₄ isomer	
10	100	dichloromethane	0.042	46	198	C ₁₁ H ₂₂ isomer	
11	105	2-methylpentane		47	201	dichlorobenzene (m or p)	
12	108	3-methylpentane		48	203	C ₁₁ H ₂₄ isomer	
12A	109	1-hexene		49	205	C ₄ -alkyl benzene isomer	
13	111	hexafluorobenzene and n-hexane		50	206	acetophenone	
14	113	trichloromethane (CHCl ₃)	30	50A	208	C ₄ -alkyl benzene isomer	
15	117	perfluorotoluene (e3)		51	209	C ₁₀ H ₁₆ isomer and C ₁₂ H ₂₆ isomer	
15A	118	methylcyclohexane		52	213	C ₄ -alkyl benzene isomer	
15B	120	C ₇ H ₁₄ isomer		53	215	C ₄ -alkyl benzene isomer	
16	122	1,1,1-trichloroethane	0.03	54	217	C ₅ -alkyl cyclohexane isomer	
17	125	benzene	10	54A		silane compound (BKG)	
17A	126	carbon tetrachloride	trace	55	219	C ₁₂ H ₂₆ isomer	
18	127	2-methylhexane		56	221	C ₅ -alkyl benzene isomer	
18B	128	C ₇ H ₁₄ isomer		56A	223	C ₄ -alkyl benzene isomer	
19	129	3-methylhexane		57	225	1,3,5-trimethylbenzene	
20	132	trichloroethylene		58	227	naphthalene	
21	134	n-heptane		60	233	C ₁₃ H ₂₈ isomer	
22	140-2	n-propylbenzene		61	240	C ₄ -alkyl benzene isomer	
22A	144	C ₈ H ₁₈ isomer		62		β-methylnaphthalene	traces
23	148	toluene	150	62A		α-methylnaphthalene	
24	152	4-methyl-2-pentanone		62B		C ₁₄ H ₂₈ isomer	
24A	153	C ₈ H ₁₆ isomer		63		n-tetradecane	
25	155	n-octane		64		biphenyl	
26	157	hexamethylcyclotrisiloxane					
27	158	tetrachloroethylene	60				
28	161	C ₉ H ₂₀ isomer					
29	163	dimethylheptane isomer					
30	165	chlorobenzene	4				
31	168	ethylbenzene					
32	169	p-xylene					
33	173	styrene					
34	175	o-xylene and n-nonane					
34A	176	1,1,2,2-tetrachloroethane	2				
35	179	C ₁₀ H ₂₀ isomer					
36	180	isopropylbenzene					

^a Ambient air sampled during period no. 5, location no. 4, see Table 15 for protocol.

Table 34. VOLATILE ORGANIC VAPORS IDENTIFIED IN AMBIENT AIR
FROM LOS ANGELES, CA^a

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	ug/m ³	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	ug/m ³
2	37	CO ₂		41	104	n-heptane	
3	40	propylene		41A	106	2,5-dimethylfuran	
4	41	dichlorodifluoromethane		42	107	2-pentanone	
5	42	chloromethane		43	109	2,2-dimethylhexane	
6	43	n-propane		44	111	methylcyclohexane	
8	45	1-butene		45	112	C ₈ H ₁₆ isomer	
9	46	n-butane		46	113	C ₇ H ₁₄ isomer and C ₈ H ₁₆ isomer	
10	49	2-butene		47	115	4-methyl-2-pentanone and C ₈ H ₁₆ isomer	
10A	50	chloroethane		48	117	4-methylheptane	
11	51	acetaldehyde		49	119	toluene	
13	55	isopentane		50	120	C ₈ H ₁₈ isomer	
14	56	trichlorofluoromethane		50A	121	isobutyl acetate (tent.)	
15	58	C ₅ H ₁₀ isomer and furan		51	122	2,4-dimethylhexane	
16	59	n-pentane		52	124	dimethylcyclohexane isomer	
17	61	C ₅ H ₁₀ isomer		52A	125	dimethylhexadiene isomer	
19	64	dichloromethane		53	127	C ₈ H ₁₆ isomer	
21	66	propanal		54	128	n-octane	
23	70	C ₆ H ₁₀ isomer		55	130	tetrachloroethylene	
23A	71	C ₆ H ₁₂ isomer		55A	131	n-butyl acetate	
24	72	2-methylpentane		56	135	C ₉ H ₂₀ isomer	
24A	73	acetone (tent.)		57	137-8	dimethylcyclohexane isomer and chlorobenzene	
25	76	3-methylpentane		58	139	C ₉ H ₁₈ isomer	
26	77	4-methyl-1-pentane		59	142	ethylbenzene	
26A	79	hexafluorobenzene (eS)		59A	143	C ₉ H ₂₀ isomer	
27	80	n-hexane and 2-methylfuran		60	144	p-xylene (or m)	
28	81	chloroform		61	145	2-methyloctane or C ₉ H ₂₀ isomer	
28A	82	3-methylfuran (tent.)		61A	148	styrene	
29	83	C ₄ H ₈ O isomer		62	149	o-xylene	
29A	84	C ₆ H ₁₂ isomer		62A	150	C ₉ H ₁₈ isomer	
30	85	perfluorotoluene (eS)		63	151	n-nonane	
31	87	methyl cyclopentane and C ₇ H ₁₆ isomer		64	152	C ₁₀ H ₂₂ isomer	
32	90	1,1,1-trichloroethane		66	158	isopropylbenzene	
32A	91	C ₇ H ₁₄ isomer and C ₆ H ₁₀ isomer		67	159	C ₁₀ H ₂₂ isomer	
33	92	methyl ethyl ketone		68	160	C ₃ -alkyl cyclohexane	
34	93	benzene and carbon tetra- chloride		68A	161	C ₁₀ H ₂₀ isomer	
35	95	cyclohexane		69	162	n-propylbenzene	
36	96	2-methylhexane		70	164	m-ethyltoluene	
37	97	C ₇ H ₁₆ isomer		71	164	C ₁₀ H ₂₂ isomer	
37A	97	C ₇ H ₁₄ isomer		72	165	1,3,5-trimethylbenzene	
38	98	3-methylhexane		73	166	C ₁₀ H ₂₀ isomer	
39	101	1,3-dimethylcyclopentane isomer		74	168	o-ethyltoluene	
40	102	trichloroethylene and methyl butanol isomer (tent.)		74A	169	α-methylstyrene	
				74B	170	C ₁₀ H ₂₀ isomer	
				75	171	1,2,4-trimethylbenzene	

(continued)

Table 34 (cont'd)

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	µg/m ³	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	µg/m ³
75A	171	C ₁₀ H ₂₀ isomer					
76	172	<u>n</u> -decane					
77	174	p (or m)-dichlorobenzene					
78	176	C ₄ -alkyl benzene isomer					
79	177	C ₁₁ H ₂₄ isomer					
80	178	C ₁₁ H ₂₄ isomer					
81	180	<u>o</u> -methylstyrene or indan					
81A	181	C ₄ -alkyl cyclohexane isomer					
81B	181	C ₁₁ H ₂₂ isomer					
82	182	sec-butylbenzene					
83	183	<u>o</u> -cymene and C ₄ -alkyl benzene isomer					
84	185	acetophenone					
85	186	C ₄ -alkyl benzene isomer					
86	188	C ₄ -alkyl benzene isomer and C ₁₀ H ₁₈ isomer					
87	189	C ₄ -alkyl benzene isomer and methyl indan isomer					
87A	190	C ₁₁ H ₂₂ isomer					
88	191	<u>n</u> -undecane					
90	196	C ₄ -alkyl benzene isomer					
91	198	C ₁₁ H ₂₀ isomer					
92	204	C ₅ -alkyl benzene isomer					
93	210	<u>n</u> -dodecane and naphthalene					

^a Ambient air was sampled at 15th and Emery St. (Fig. 10), see Table 17 for protocol; volume of air was 0.1 of sample in Table 35.

Table 35. VOLATILE ORGANIC VAPORS IDENTIFIED IN AMBIENT AIR
FROM LOS ANGELES, CA^a

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	ng/m ³	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	ng/m ³
1	40	N ₂		48	119	bromofluoromethane (tent.)	
2	40	O ₂		49	119	C ₉ H ₂₀ isomer	
3	42	CO ₂		50	120	dimethylhexane	
5	46	dichlorodifluoromethane		51	120	C ₇ H ₁₄ isomer	
6	48	butene		52	121	2-hexanone	
7	49	butane		53	122	C ₈ H ₁₆ isomer	
8	51	chloropropane (tent.)		54	123	C ₈ H ₁₆ isomer	
9	56	acetaldehyde	-125,000	55	123	dihdropyran	
10	61	isopentane		56	124	dimethylhexane	
11	63	trichlorofluoromethane		57	126	toluene	
12	64	furan		58	127	C ₈ H ₁₈ isomer	
13	65	pentane		59	128	C ₈ H ₁₆ isomer	
14	66	vinyl methyl ether		60	129	C ₈ H ₁₈ isomer	
15	67	acrolein		61	132	C ₈ H ₁₆ isomer	
16	68	ethanol		62	132	C ₇ H ₁₆ isomer	
17	70	CH ₂ Cl ₂		63	133	C ₈ H ₁₄ isomer	
18	72	freon 113 (BKG)		64	135	C ₈ H ₁₈ isomer	
19	72	acetone		65	136	n-propyl acetate	
20	76	monovinyl glycol ether (tent.)		66	137	C ₈ H ₁₆ isomer	
21	80	methylpentane		67	138	tetrachloroethylene	
22	83	methylpentane		69	140	C ₈ H ₁₆ isomer	
23	85	perfluorobenzene (eW)		70	142	C ₉ H ₂₀ isomer	
24	86	hexane		71	144	C ₉ H ₂₀ isomer	
25	86	chloroform		72	145	C ₈ H ₁₆ isomer	
26	88	methyl ethyl ketone		73	146	chlorobenzene	
27	92	perfluorotoluene (eW)		74	146	C ₉ H ₁₈ isomer	
28	94	methylcyclopentane		75	149	ethylbenzene	
29	95	dimethyl ethylhexane (tent.)		76	150	C ₉ H ₂₀ isomer	
30	96	1,1,1-trichloroethane	8,340	77	151	dimethylbenzene	
31	100	benzene	18,421	78	152	C ₉ H ₂₀ isomer	
32	101	methylheptane		79	152	C ₉ H ₁₆ isomer	
33	101	CCl ₄		80	153	C ₉ H ₁₈ isomer	
34	102	cyclohexane		81	155	styrene	
35	102	dimethylheptane		82	156	dimethylbenzene	
36	103	C ₇ H ₁₆ isomer		83	157	C ₉ H ₁₈ isomer	
37	105	C ₇ H ₁₄ isomer		84	157	C ₉ H ₂₀ isomer	
38	107	heptanol		85	160	2,4-dibromo-1-butene (tent.)	
39	108	C ₇ H ₁₄ isomer		86	162	C ₉ H ₁₈ isomer	
40	109	trichloroethylene		87	163	methyl ethylbenzene	
41	110	C ₇ H ₁₆ isomer		88	163	C ₁₀ H ₂₂ isomer	
42	110	C ₇ H ₁₂ isomer		89	164	C ₉ H ₁₆ isomer	
43	111	C ₇ H ₁₄ isomer		90	164	C ₉ H ₁₈ isomer	
44	112	dimethylfuran		91	165	C ₁₀ H ₂₂ isomer	
45	114	C ₇ H ₁₄ isomer		92	166	C ₉ H ₁₈ isomer	
46	116	trimethylpentane		93	166	C ₁₀ H ₂₀ isomer	
47	118	dimethylpentene		94	167	C ₉ H ₂₀ isomer	

(continued)
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Table 35 (cont'd)

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	ng/m ³	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	ng/m ³
95	166	C ₁₀ H ₂₀ isomer		141	198	C ₁₁ H ₂₂ isomer	
96	169	benzaldehyde		142	199	C ₅ -alkyl benzene isomer	
97	169	C ₁₀ H ₂₀ isomer		143	200	C ₁₁ H ₂₂ isomer	
98	170	trimethylbenzene		144	200	C ₅ -alkyl benzene isomer	
99	171	C ₁₀ H ₂₂ isomer		145	201	C ₁₁ H ₂₂ isomer	
100	172	trimethylbenzene		146	202	C ₁₁ H ₂₂ isomer	
101	172	C ₁₁ H ₂₄ isomer		147	202	C ₁₂ H ₂₆ isomer	
102	173	C ₁₀ H ₂₀ isomer		148	202	C ₄ -alkyl benzene isomer	
103	173	C ₁₀ H ₂₂ isomer		149	203	C ₁₂ H ₂₄ isomer	
104	174	C ₁₀ H ₂₀ isomer		150	204	C ₅ -alkyl benzene isomer.	
105	175	benzonitrile		151	205	C ₁₁ H ₂₀ isomer	
106	175	trimethylbenzene		152	206	C ₁₂ H ₂₄ isomer	
108	176	C ₁₀ H ₂₀ isomer		153	206	C ₅ -alkyl benzene isomer	
109	176	methyl cyclopropyl ketone (tent.)		154	207	methylallylbenzene	
110	177	C ₁₀ H ₂₀ isomer		155	207	C ₅ -alkyl benzene isomer	
111	178	C ₃ -alkyl benzene isomer		156	208	phenylcyclohexylethane (tent.)	
112	179	C ₁₀ H ₂₂ isomer		157	208	C ₁₂ H ₂₆ isomer	
113	180	phenol		158	209	C ₁₁ H ₂₀ isomer	
114	181	C ₄ -alkyl benzene isomer		159	209	C ₅ -alkyl benzene	
115	182	dichlorobenzene		160	210	C ₁₂ H ₂₆ isomer	
116	182	C ₄ -alkyl benzene isomer		161	210	ethylstyrene	
117	183	C ₁₁ H ₂₄ isomer		162	211	C ₆ -alkyl benzene isomer	
118	184	C ₃ -alkyl benzene isomer		163	211	C ₁₂ H ₂₄ isomer	
119	184	C ₁₁ H ₂₄ isomer		164	212	C ₅ -alkyl benzene isomer	
120	186	C ₁₀ H ₁₈ isomer		165	214	C ₁₂ H ₂₂ isomer	
121	187	C ₁₁ H ₂₂ isomer		166	214	C ₁₂ H ₂₄ isomer	
122	187	dichlorobenzene		167	214	C ₁₃ H ₂₆ isomer	
123	187	C ₁₁ H ₂₂ isomer		168	215	trichlorobenzene	
124	187	C ₁₁ H ₂₄ isomer		169	216	C ₁₂ H ₂₆ isomer	
125	188	dihydroindene		170	216	naphthalene	
126	188	C ₁₀ H ₂₀ isomer		171	217	C ₅ -alkyl benzene isomer	
127	188	C ₁₁ H ₂₂ isomer		172	219	C ₁₃ H ₂₈ isomer	
128	189	C ₄ -alkyl benzene isomer		173	220	C ₁₁ H ₂₄ isomer	
129	190	C ₄ -alkyl benzene isomer		174	221	C ₆ -alkyl benzene isomer	
130	190	acetophenone		175	224	C ₅ -alkyl benzene isomer	
131	191	C ₁₁ H ₂₂ isomer		176	225	C ₄ -alkyl phenol (tent.)	
132	191	C ₁₁ H ₂₄ isomer		177	226	cyclohexylphenol (tent.)	
133	193	C ₁₁ H ₂₂ isomer		178	230	C ₁₃ H ₂₆ isomer	
134	193	C ₄ -alkyl benzene isomer		179	233	C ₁₃ H ₂₈ isomer	
135	194	C ₄ -alkyl benzene isomer		180	235	C ₁₄ H ₂₈ isomer	
136	194	C ₁₀ H ₁₈ isomer		181	236	methylnaphthalene	
137	196	C ₁₁ H ₂₀ isomer		182	240	C ₁₃ H ₂₄ isomer	
138	196	C ₁₁ H ₂₂ isomer		183		methylnaphthalene	
139	196	dimethylstyrene		184		C ₁₃ H ₂₈ isomer	
140	197	C ₁₁ H ₂₄ isomer		185		biphenyl	
				186		C ₁₄ H ₃₀ isomer	

^a Ambient air was sampled at 15th and Emery St. (Fig. 10), see Table 17 for protocol.

Table 36. VOLATILE ORGANIC VAPORS IDENTIFIED IN AMBIENT AIR
FROM DOMINQUEZ, CA^a

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	ng/m ³	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	ng/m ³
		CO ₂		37	117	methylcyclohexane	
		cyclopropane		37A	117	C ₈ H ₁₆ isomer	
1	46	dichlorodifluoromethane		38	118	C ₈ H ₁₈ isomer	
2	48	chloromethane		39	119	4-methyl-2-pentanone	
2A	49	propane		40	121	C ₈ H ₁₆ isomer	
3	51	1-butene		41	123	C ₈ H ₁₆ isomer	
4	52	n-butane		42	124	1,1,2-trichloroethane	12,500
5	53	SO ₂		43	126	toluene + C ₈ H ₁₈ isomer	
6	56	chloroethane		44	126	3-methylheptane	
7	56	acetaldehyde		45	131	dimethylcyclohexane isomer	
9	61	isopentane		46	132	3-hexanone	
10	62	trichlorofluoromethane		47	133	C ₈ H ₁₆ isomer	
10A	63	C ₅ H ₁₀ isomer		48	135	n-octane	
11	64	C ₅ H ₁₀ isomer + furan		49	136	n-butyl acetate	1,670
12	65	n-pentane		50	137	tetrachloroethylene	20,000
13	67	propanal		51	139	C ₈ H ₁₆ isomer	
13A	68	dichloromethane		52	140	C ₉ H ₂₀ isomer	
14	70	acetone		53	141	C ₉ H ₂₀ isomer	
16	78	1,1-dichloroethane		53A	142	C ₉ H ₁₈ isomer	
16A	79	2-methylpentane		54	143	C ₉ H ₂₀ isomer	
16B	80	3-methylpentane		55	144	methyl ethyl cyclopentane isomer	
17	83	C ₆ H ₁₄ isomer		55A	144	chlorobenzene	
18	84	C ₆ H ₁₂ isomer		56	145	trimethylcyclohexane isomer	
19	85	hexafluorobenzene (e3)		56A	146	n-nonane	
19A	85	2-methylfuran		57	148	ethylbenzene	
20	86	n-hexane		57A	149	C ₉ H ₂₀ isomer	
21	87	chloroform		58	151	p-xylene	
21A	88-9	methyl ethyl ketone		59	152	C ₉ H ₂₀ isomer	
22	92	perfluorotoluene (e3)		60	153	2-heptanone	
23	93	methylcyclopentane		60A	154	2-butylfuran + C ₉ H ₁₈ isomer	
24	94	1,2-dichloroethane	14,814	61	155	styrene	
24A	96	1,1,1-trichloroethane		61A	155	C ₉ H ₁₈ isomer	
24B	97	C ₇ H ₁₄ isomer		62	156	o-xylene	
25	98	C ₆ H ₁₀ isomer		62A	157	C ₉ H ₁₈ isomer	
26	100	benzene	34,210	63	158	n-nonane	
27	101	carbon tetrachloride		64	159	C ₁₀ H ₂₀ isomer	
27A	101	cyclohexane		65A	161	methylethylcyclohexane isomer	
28	102	2-methylhexane		65	161	C ₁₀ H ₂₂ isomer	
29	103	2,3-dimethylpentane		66	162	isopropylbenzene	
30	105	3-methylhexane		67	163	C ₁₀ H ₂₀ isomer	
31	107	dimethylcyclopentane isomer		68	164	2,5-dimethyloctane	
32	108	dimethylcyclopentane isomer		69	165	3-methylnonane	
33	109	trichloroethylene	9,210	70	166	n-propylcyclohexane + C ₁₀ H ₂₀ isomer	
34	110	n-heptane					
35	113	2,5-dimethylfuran					
36	116	trimethylpentane isomer					

(continued)

Table 36 (cont'd)

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	ng/m ³	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	ng/m ³
71	167	octanone isomer + C ₁₀ H ₂₂ isomer		99	197	C ₁₁ H ₂₂ + methylindan isomer	
72	168	C ₁₀ H ₂₀ isomer		100	198	n-undecane	
73	169	benzaldehyde + n-propylbenzene		101	200	C ₅ -alkyl benzene + C ₁₁ H ₂₂ isomer	
73A	170	C ₁₀ H ₂₂ isomer		101A	200	C ₄ -alkyl benzene + C ₁₂ H ₂₄ isomer	
74	171	m-ethyltoluene		102	201	C ₁₁ H ₂₄ isomer	
75	171	C ₁₀ H ₂₂ isomer		103	202	C ₁₂ H ₂₆ isomer	
76	172	1,3,5-trimethylbenzene		104	203	tetramethylbenzene isomer	
77	173	C ₁₀ H ₂₂ isomer		105	203	C ₁₂ H ₂₆ isomer	
77A	173	cyanobenzene		105A	204	C ₁₁ H ₂₀ isomer	
78	174	6-methyl-2-heptanone (tent.)		106	205	C ₅ -alkyl benzene isomer	
79	175	o-ethyltoluene		107	206	C ₅ -alkyl benzene isomer	
80	176	C ₁₀ H ₁₈ isomer			206	C ₅ -alkyl cyclohexane isomer	
81	176	C ₁₀ H ₂₀ isomer		108	207	methylindan + C ₁₂ H ₂₄ isomer	
82	178	1,2,4-trimethylbenzene		108A	208	C ₅ -alkyl benzene isomer	
83	179	n-decane		109	208	C ₁₂ H ₂₆ isomer	
83A	179	phenol		110	209	C ₁₁ H ₂₀ isomer	
84	180	C ₁₀ H ₂₀ isomer		111	210	C ₄ -alkyl benzene isomer	
84A	180	isobutylbenzene		111A	210	C ₅ -alkyl benzene + C ₁₂ H ₂₆ isomer	
85	181	m-dichlorobenzene		111B	211	C ₄ -alkyl benzene isomer	
85A	181	sec-butylbenzene		112	211	C ₅ -alkyl benzene + C ₁₂ H ₂₆ isomer	
86	182	C ₁₁ H ₂₄ isomer		112A	212	C ₁₂ H ₂₄ + C ₁₂ H ₂₂ isomers	
86A	182	C ₄ -alkyl benzene isomer		113	213	C ₅ -alkyl benzene isomer	
87	183	C ₁₁ H ₂₄ isomer		113A	213	C ₁₃ H ₂₆ isomer	
88	184	4-methyldecane + 1,2,3-tri- methylbenzene		114	214	C ₁₂ H ₂₄ isomer	
89	185	C ₁₁ H ₂₄ isomer		115	215	trichlorobenzene + C ₁₂ H ₂₄ isomer	1,700
89A	185	C ₁₁ H ₂₂ isomer		116	216	n-dodecane + naphthalene	
90	186	C ₁₁ H ₂₄ + o-dichlorobenzene		116A	217	C ₁₂ H ₂₄ + trimethylindan isomers	
91	187	indan		117	219	C ₁₂ H ₂₂ + C ₁₃ H ₂₈ isomers	
91A	188	n-butylcyclohexane + C ₁₁ H ₂₂ isomer		118	220	C ₁₃ H ₂₆ isomer	
92	189	diethylbenzene isomer		120	224	C ₁₃ H ₂₆ isomer	
92A	189	p-propyltoluene		121	225	C ₁₃ H ₂₆ isomer	
93	190	m-propyltoluene + n-butyl- benzene		121A	225	C ₆ -alkyl cyclohexane isomer	
94	191	acetophenone		122	226	C ₁₃ H ₂₈ isomer	
95	191	C ₁₁ H ₂₄ isomer		123	227	C ₁₃ H ₂₆ isomer	
95A	192	C ₁₁ H ₂₂ isomer		124	228	C ₁₄ H ₃₀ isomer	
96	193	o-propyltoluene + C ₁₁ H ₂₄ isomer		125	229	methyltridecane isomer	
97	195	C ₄ -alkyl benzene + C ₁₀ H ₁₈ isomer		126	230	C ₁₄ H ₃₀ isomer	
98	196	C ₄ -alkyl benzene + C ₁₁ H ₂₂ isomer		127	231	C ₁₃ H ₂₆ isomer	
98A	196	C ₁₁ H ₂₀ isomer		128	233	n-tridecane	
				129	235	C ₁₄ H ₂₈ isomer	
				130	237	β-methylnaphthalene	

(continued)

Table 36 (cont'd)

Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	ng/m ³	Chromato- graphic Peak No.	Elution Temp. (°C)	Compound	ng/m ³
131	238	C ₁₄ H ₂₈ isomer					
131A	239	C ₁₃ H ₂₄ isomer					
132	240	α -methylnaphthalene					
133	isothermal	C ₁₃ H ₂₈ isomer					
135		C ₇ -alkyl cyclohexane isomer					
136		C ₁₄ H ₃₀ isomer					
137		C ₁₅ H ₃₂ isomer					
138		<u>n</u> -tetradecane					
140		C ₁₄ H ₃₀ isomer					
142		dimethylnaphthalene isomer					
143		dimethylnaphthalene isomer					
144		C ₁₆ H ₃₄ isomer					
145		<u>n</u> -pentadecane					

^a Ambient air sampled at 2055 223 St., Dominquez, CA (Fig. 11) see Table 17 for protocol.

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

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