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Project Summary

Indoor Air Quality in Public Buildings: Volume II

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This report documents the second of two studies of indoor air quality in public buildings carried out by the U.S. Environmental Protection Agency in response to public and Congressional concern. A total of 10 buildings were studied in the program. A report on the first four buildings is being published simultaneously with this report, which deals with the last six buildings investigated.

This Project Summary was developed by EPA's Environmental Monitoring Systems Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

In FY 1982 and again in FY 1983, Congress mandated that the U.S. Environmental Protection Agency (EPA) carry out studies of indoor air quality. The studies were focused on volatile organic compounds (VOCs) for several reasons: 1) VOCs include a number of carcinogenic and mutagenic species (benzene, chloroform, tetrachloroethylene, etc.); 2) little was known at the time about human exposure to these compounds; and 3) methodology had recently been developed to measure these compounds at environmental levels. Because these compounds were being extensively studied in private homes in EPA's ongoing Total Exposure Assessment Methodology (TEAM) Study (Wallace 1987; Pellizzari 1987a,b; Handy 1987), the study concentrated on buildings rather than homes. Buildings where people spend long periods of time were selected for study: schools, homes for the elderly, hospitals, and office buildings. These buildings also contain populations (children, the sick and the elderly) that may be more sensitive to air pollutants.

Two separate but closely related studies were carried out. The first included measurements in four buildings (one school, one office building, and two homes for the elderly). The final report of that study, an EPA Research Report entitled *Indoor Air Quality in Four Buildings*, is now available (Sheldon et al., 1988). A separate Project Summary has been written for that report.

The second study included six buildings (a hospital, two office buildings, two homes for the elderly, and an institute for governmental studies). The final report for that study is entitled *Indoor Air Quality in Six Buildings*. This Project Summary refers to this second study only.

Study Design

The goals of the study were the following:

1) Quantify a set of target VOCs, selected on the basis of their potential health effects, production volume, and amenability to collection on Tenax, in all samples.
2) Determine the effect of aging on the concentrations of VOCs within three newly constructed buildings.
3) Measure emissions of VOCs from building material collected from one of the new buildings.
4) Measure concentrations of other chemicals or mixtures including radon, formaldehyde, particles, pesticides, PCBs, polynuclear aromatic hydrocarbons (PAHs), metals, carbon monoxide, nitrogen dioxide, and asbestos.

Six buildings were selected for study: a hospital and an associated nursing home in Martinsburg, WV; a home for the elderly in Worcester, MA; an office building in Washington, DC; another office building in Fairfax, VA; and an institute for governmental studies in Cambridge, MA. The hospital,

the Worcester home for the elderly, and the Fairfax office building were new buildings, scheduled to be monitored immediately after completion but before occupancy, and then again a few months after occupancy. (Unfortunately, the new hospital was not actually monitored until almost one year after it had been finished; therefore only two buildings were monitored when they were new.) The remaining three buildings were existing buildings ranging in age from 3-8 years. These buildings were monitored once only.

Each monitoring visit lasted three days. Three indoor sites were selected and one outdoor site (near the air intake for the building) was monitored over consecutive 12-hour periods. Air exchange rates were determined for each 12-hour period by injecting sulfur hexafluoride (SF_6) into the building ventilation system and measuring the decay in concentration.

Measurement Methods

Measurement methods are described fully in the report. Following is a brief description for selected pollutant classes.

1) *Volatile organics.* Thirty-two target VOCs were collected in cartridges containing 1.5 g of 35/60 mesh Tenax. All samples were collected in triplicate, using different flow rates designed to provide 10, 15, and 20 liters of air over the 12-hour collection period. Thermal desorption was followed by GC-MS analysis.

2) *Particles.* Inhalable particles including both the fine ($<2.5\mu$) and coarse ($2.5\text{-}10\mu$) fractions were collected on samplers designed for EPA by the National Bureau of Standards. An 8μ Nuclepore filter was used for the coarse particles and a 3μ Ghia Zefluor Teflon filter for the fine particles. The filters were weighed by microbalance following exposure to an ionizing source to reduce static charge.

3) *Emissions from materials.* A total of 31 materials (22 solid and 9 solvent-based surface coatings) were collected from the new office building in Fairfax, VA when possible or purchased from the manufacturer. Headspace vapors from gently heated (30 - 34°C) solid materials in 70-ml glass jars were collected overnight (or over 30 minutes for the solvent-based materials) on Tenax cartridges using a dynamic purging technique and analyzed by GC-MS for the target compounds. Based on the results of these preliminary headspace experiments, nine materials (vinyl and rubber molding, cove adhesive, particle board, etc.) were selected for detailed emission studies using 12-L glass chambers. Solid materials were aged for 14-25 weeks, solvent-based materials for one week. Materials were placed in the chamber, allowed to equilibrate overnight at 25°C and 48% relative humidity, and their organic emissions were then collected on three consecutive Tenax cartridges and analyzed by GC-MS.

Results

Quality Assurance

Fifty performance evaluation audit samples supplied by EPA showed recovery efficiencies ranging from 72±19% to 95±34% for nine target VOCs. Forty-one blank Tenax cartridges had nondetectable levels for 24 of the 32 target VOCs and levels under 10 ng/cartridge for seven of the remaining eight VOCs. Precision for most VOCs was excellent, with median relative standard deviations ranging between 11% and 24% for 26 of the 29 compounds with measureable levels (Table 1). One exception was the cresols, which appeared to be unreliably collected.

All Tenax samples were collected in triplicate at widely ranging flow rates (sampling volumes of 10, 15, and 20L) as a means of detecting possible artifact formation or other problems occurring during sampling that would not be detected using normal quality control techniques. Concentrations that vary with changing flow rate would be evidence that such problems were indeed occurring. However, the geometric means of the different sampling volumes were within 10% of each other for 25 of the 29 compounds (Table 2). Thus no evidence of significant sampling problems emerged from this extensive effort at using "distributed volume" sampling.

Quantitative Results

Indoor concentrations of VOCs were higher than outdoor concentrations at all six buildings (Tables 3 and 4). However, for the two new buildings monitored within one month after construction, certain chemicals were at extemely elevated concentrations: the straight-chain aliphatic hydrocarbons (*n*-decane, *n*-undecane, *n*-dodecane) and the aromatics (xylene isomers, ethylbenzene, ethyltoluene isomers, and trimethylbenzene isomers). Indoor levels of these compounds shortly after the buildings' construction ranged from 10-400 $\mu g/m^3$, while outdoor concentrations ranged from 0-1 $\mu g/m^3$. After several months, the indoor levels dropped to a range of about 3-30$\mu g/m^3$—still well above the outdoor concentrations.

Emission rates from 31 materials collected from the new office building are summarized in Table 5. Although some solvent-based materials were the highest emitters, as might be expected, other solvent-based materials such as linoleum tile cement and joint compound emitted none of the target VOCs (Figure 1). Some solid materials, particularly rubber and vinyl molding, linoleum tile, and telephone cable, also emitted significant quantities of the target VOCs (Figure 2). Common emissions included xylenes, ethylbenzene, trimethylbenzenes, ethyltoluenes, decane, undecane, and dodecane. 24 of the 32 target chemicals were emitted by at least one material; and 24 of the 31 materials emitted at least one target chemical. Some chemicals such as xylenes and trimethylbenzenes were emitted by as many as 18 or 19 materials, while some materials such as latex caulk and cove adhesive emitted as many as 17 of the target chemicals.

Fine particle mass averaged over 12-hour periods by the EPA-NBS sampler ranged from 14-55 $\mu g/m^3$ in smoking areas, compared to 3-38 $\mu g/m^3$ in nonsmoking areas.

Air exchange measurements for the ten monitoring visits ranged from 0.14 to 0.94 air changes per hour (ach), with both extreme values occurring during different visits to the new hospital (Table 6). If the rates are averaged across all visits to each building, the range is unusually small—0.43-0.54 ach.

Discussion

The extensive effort at "distributed volume" sampling (over 200 triplicate samples) indicated no significant problems occurred during sampling of either indoor or outdoor air using Tenax. This result confirms and extends the results of a study of indoor air under controlled conditions, which concluded that no differences could be observed among 10 compounds measured simultaneously on Tenax and in evacuated canisters (Spicer, 1986).

Indoor concentrations of VOCs in the six buildings studied exceeded outdoor concentrations for all of the prevalent target chemicals except benzene, indicating the presence of indoor sources in all buildings. The two new buildings had high concentrations of aromatic and aliphatic hydrocarbons immediately after completion, with concentrations declining by an order of magnitude over the next few months. This is further corroboration of the finding from the earlier EPA study (Wallace 1987c) that half-lives of the chemicals involved may be measured in weeks or months and that therefore the time required for these new buildings to approach outdoor concentrations may be measured in months or even up to one year.

The measurement of emissions from 31 building materials collected from one building shows that the same chemicals found at elevated levels in that building are emitted at high rates from some of those building materials and surface coatings. These

Table 1. *Precision for Volatile Organic Analysis*

Compound	N[a]	% RSD				
		Mean	25TH Percentile	50TH Percentile	75TH Percentile	90TH Percentile
Aromatic Hydrocarbons						
Benzene	233	25	11	21	34	47
m, p-Xylene	231	17	9	15	22	29
o-Xylene	222	18	10	15	24	35
Styrene	226	28	12	21	37	57
Ethylbenzene	229	17	9	15	22	32
Isopropylbenzene	128	17	10	15	22	30
n-Propylbenzene	104	15	8	13	21	29
m-Ethyltoluene	218	16	8	14	21	29
o-Ethyltoluene	144	16	7	14	23	31
1,2,3-Trimethylbenzene	218	23	10	17	27	40
1,2,4-Trimethylbenzene	224	17	8	14	21	31
1,2,5-Trimethylbenzene	119	16	7	13	22	32
Aliphatic Hydrocarbons						
α-Pinene	69	22	12	20	28	44
n-Decane	151	20	11	16	26	35
n-Undecane	151	21	11	18	27	39
n-Dodecane	73	18	10	15	22	32
Chlorinated Hydrocarbons						
1,2-Dichloroethane	52	18	8	15	23	31
1,1,1-Trichloroethane	229	21	11	18	25	42
Trichloroethylene	113	26	12	22	34	49
Tetrachloroethylene	123	16	8	14	21	30
p-Dichlorobenzene	77	14	5	11	18	23
Chlorobenzene	7	15	12	16	17	18
Carbon tetrachloride	12	29	7	14	49	106
o-Dichlorobenzene	6	37	4	13	56	171
Oxygenated Hydrocarbons						
n-Butylacetate	73	28	15	24	36	47
2-Ethoxyethyl acetate	40	23	12	22	31	39

[a]*Number of samples.*

Table 2. *Results of Distributed Volume Sampling*

Chemical	N	Mean[a]	SD[b]	RSD(%)[c]
n-butylacetate	65	2.25	0.03	1
n-dodecane	63	22.84	0.32	1
n-propylbenzene	95	1.55	0.02	1
1,3,5-trimethylbenzene	108	2.67	0.04	1
p-dichlorobenzene	67	1.71	0.03	2
a-pinene	59	8.70	0.29	3
ethylbenzene	210	2.59	0.08	3
tetrachloroethylene	112	1.74	0.05	3
trichloroethylene	94	1.85	0.05	3
o-xylene	197	2.80	0.075	3
1,1,1-trichloroethane	207	4.45	0.12	3
isopropylbenzene	119	0.76	0.03	4
m-xylene	216	6.56	0.24	4
n-undecane	127	11.25	0.41	4
o-ethyltoluene	212	0.66	0.025	4
1,2,3-trimethylbenzene	208	0.99	0.04	4
1,2,4-trimethylbenzene	200	3.00	0.11	4
n-decane	130	10.27	0.49	5
m-ethyltoluene	196	2.58	0.16	6
o-cresol	14	1.07	0.06	6
1,2-dichloroethane	43	2.58	0.17	7

chemicals—a set of 10 aromatic and aliphatic VOCs—were identical in both of the new buildings studied, indicating that the findings may be generally true for many buildings. The materials emitting these chemicals at the highest rates were surface coatings such as adhesives, caulking, and paints; wall and floor coverings such as molding, linoleum tile, and carpet; and miscellaneous other materials such as telephone cables. Structural materials such as brick and mineral board had few organic emissions. Surprisingly however, some solvent-based materials such as linoleum tile cement and joint compound and some other materials such as ceiling tile and plastic laminates also had no detectable emissions of the target compounds. These findings confirm the findings of the earlier EPA study (Sheldon 1988; Wallace 1985) on emissions from 19 building materials.

Because building renovations utilize many of the same materials (adhesives, paints

Table 2. (Continued)

Chemical	N	Mean[a]	SD[b]	RSD(%)[c]
styrene	203	1.26	0.11	9
chlorobenzene	7	1.16	0.12	10
o-dichlorobenzene	4	1.71	0.025	10
2-ethoxyethylacetate	50	3.53	0.36	10
benzene	215	2.68	0.35	13
carbon tetrachloride	19	0.81	0.12	15
bromodichloromethane	3	0.98	0.24	24
m-cresol	41	5.35	1.66	31

[a] Mean of the three geometric means for the three sampling volumes.
[b] Standard deviation of the three geometric means.
[c] Relative standard deviation

carpets, etc.) that cause elevated VOC concentrations in new buildings, it appears possible that similar elevated concentrations will occur in buildings that are being renovated or refurbished.

Two types of health effects may be associated with the elevated concentrations of organic gases and particles reported here. First, chronic health effects, including cancer, may be caused by long-term exposure to some of these compounds. Chloroform, trichloroethylene, tetrachloroethylene, carbon tetrachloride, and p-dichlorobenzene are animal carcinogens and therefore possible human carcinogens. The elevated particle

Table 3. Mean Indoor Concentration of Volatile Organic Compounds for all Monitoring Trips

	Mean Indoor Concentration (ng/L)									
	Martinsburg, WV			Fairfax, VA		Worcester, MA		Washington, DC	Cambridge, MA	Martinsburg, WV
	Hospital (New)[a]			Office (New)[b]		Nursing[c] Home (New)		Office (Old)	Office/ School (Old)	Nursing Home (Old)
Compound	Trip 1 (7/84)	Trip 2 (10/84)	Trip 3 (8/85)	Trip 1 (1/85)	Trip 2 (4/85)	Trip 1 (4/85)	Trip 2 (8/85)	Trip 1 (8/84)	Trip 1 (2/85)	Trip 1 (7/84)
Aromatic Hydrocarbons										
Benzene	1.55	2.13	2.88	2.74	4.95	1.70	2.44	5.61	4.50	3 13
m-Xylene	6.88	3.13	9.91	41.53	15.05	23.80	5.33	27.11	8.72	2.95
o-Xylene	3.05	0.92	3.07	18.40	3.67	8.92	2.07	9.28	3.43	0.99
Styrene	1.00	1.07	1.33	2.52	2.87	2.99	1.27	2.36	1.32	1.19
Ethylbenzene	1.94	1.01	2.88	51.26	5.37	7.90	2.15	10.15	2.69	0.97
Isopropylbenzene	0.31	ND[d]	0.33	3.94	0.67	2.27	0.33	0.79	0.36	ND
n-propylbenzene	ND	ND	ND	5.00	1.13	2.99	0.70	1.22	0.56	ND
m-Ethyltoluene	1.11	0.86	1.48	27.41	5.57	12.38	2.62	6.07	2.62	0.90
o-Ethyltoluene	ND	ND	0.66	8.89	2.08	4.01	0.73	1.60	0.74	ND
1,2,3-Trimethylbenzene	0.63	0.43	0.76	15.10	2.91	5.32	0.72	1.80	1.06	0.79
1,2,4-Trimethylbenzene	1.48	0.98	1.82	73.51	7.27	13.95	2.52	6.28	2.80	0.98
1,3,5-Trimethylbenzene	ND	ND	0.75	16.97	2.75	6.83	0.92	1.83	1.14	ND
Aliphatic Hydrocarbons										
α-Pinene	ND	ND	ND	14.13	24.64	5.19	ND	ND	2.65	ND
n-Decane	3.65	2.73	2.71	436.38	15.24	68.27	3.81	2.26	5.98	1.87
n-Undecane	3.31	1.96	2.34	210.80	33.93	68.51	3.48	2.85	6.77	ND
n-Dodecane	ND	ND	ND	152.69	23.74	31.42	ND	ND	2.23	ND
Chlorinated Hydrocarbons										
1,2-Dichloroethane	2.06	1.49	2.21	ND	4.51	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	4,98	4,50	15,54	12,54	38,85	4,03	1,76	40.98	10.69	3.09
Trichloroethylene	1.05	ND	ND	ND	7.93	2.58	0.57	0.61	10.89	ND
Tetrachloroethylene	ND	ND	1.79	ND	1.64	1.13	0.96	3.97	4.11	0.99
p-Dichlorobenzene	ND	ND	6.61	ND	2.64	2.17	0.62	0.60	ND	ND
Oxygenated Hydrocarbons										
n-Butylacetate	ND	ND	ND	ND	6.34	ND	1.22	2.63	1.48	ND
2-Ethoxyethyl acetate	1.31	ND	ND	ND	2.16	9.58	ND	1.67	ND	ND

[a] Building completed ~34 weeks before first monitoring trip.
[b] Building completed ~1 week before first monitoring trip.
[c] Building completed ~4 weeks before first monitoring trip.
[d] Below the quantifiable limit.

Table 4. Concentration Data for Volatile Organics Summarized by Compound Class

	Time Since Completion (Weeks)	Concentration (ng/L)														
		Aromatic Hydrocarbons			Aliphatic Hydrocarbons			Chlorinated Hydrocarbons			Oxygenated Hydrocarbons			Total		
		Indoor	Outdoor	In/Out Ratio	Indoor	Outdoor	In/Out Ratio	Indoor	Outdoor	In/Out Ratio	Indoor	Outdoor	In/Out Ratio	Indoor	Outdoor	In/Out Ratio
Hospitals																
Hospital (New)																
Trip 1 (7/84)	~34	18	5.4	3.3	7.0	ND[a]	—[b]	8.1	3.7	2.2	1.3	ND	—	34	9.1	3.7
Trip 2 (10/84)	~48	11	5.1	2.2	4.7	ND	—	6.0	5.3	1.1	ND	ND	—	21	10	2.1
Trip 3 (8/85)	~1.5 y	26	6.2	4.2	5.1	ND	—	26	3.2	8.1	ND	ND	—	57	9.4	6.1
Offices																
Office (New)																
Trip 1 (1/85)	~1	270	16	17	810	ND	—	13	1.0	13	ND	ND	—	1100	17	65
Trip 2 (4/85)	14	54	13	4.2	98	ND	—	56	3.0	19	8.5	ND	—	220	16	14
Office (Old)																
Trip 1 (8/84)	~1 y	74	50	1.5	5.1	ND	—	46	8.1	5.6	4.3	ND	—	130	58	2.2
Office/School (Old)																
Trip 1 (2/85)	~2 y	30	12	2.5	18	ND	—	26	3.7	7.0	1.5	ND	—	75	16	4.6
Homes																
Nursing Home (New)																
Trip 1 (4/85)	~4	93	8.5	11	173	ND	—	9.9	2.8	3.5	9.6	ND	—	286	11	26
Trip 2 (8/85)	~23	22	17	1.3	7.3	ND	—	3.9	2.5	1.6	1.2	ND	—	34	20	1.7
Nursing Home (Old)																
Trip 1 (7/84)	~8 y	12	7.8	1.5	1.9	ND	—	4.1	1.3	3.2	ND	ND	—	18	9.1	2.0

[a] Below the quantifiable limit.
[b] Not calculated

Table 5. Summary of Emission Results

Sample[a]	Emmission Rate ($\mu g/m^2h$)			
	Aliphatic and Oxygenated Aliphatic Hydrocarbons	Aromatic Hydrocarbons	Halogenated Hydrocarbons	All Target Compounds
Cove adhesive	[a]	[a]	[a]	>5000
Latex caulk	252	380	5.2	637
Latex paint (Glidden)	111	52	86	249
Carpet adhesive	136	98	[b]	234
Black rubber molding	24	78	0.88	103
Small diameter telephone cable	33	26	1.4	60
Vinyl cove molding	31	14	0.62	46
Linoleum tile	6.0	35	4.0	45
Large diameter telephone cable	14	20	4.3	38
Carpet	27	9.4	-	36
Vinyl edge molding	18	12	0.41	30
Particle board	27	1.1	0.14	28
Polystyrene foam insulation	0.19	20	1.4	22
Tar paper	3.2	3.1	-	6.3
Primer/adhesive	3.6	2.5	-	6.1
Latex paint (Bruning)	-	3.2	-	3.2
Water repellant mineral board	1.1	0.43	-	1.5

loadings associated with the smoking areas of these buildings supplements earlier work (Repace 1980, Spengler 1985) indicating increased exposure to environmental tobacco smoke (ETS), a probable human carcinogen, in these buildings, which house children, the sick and the elderly. Risk assessments have been carried out for VOCs (Wallace, 1986; Tancrede, 1987) and for ETS (Repace and Lowrey, 1985; NAS, 1986) in the home environment and have concluded that risks are considerably greater for these chemicals in indoor air than in outdoor air or (except for chloroform) in drinking water. The risks associated with the type of buildings studied here would be proportional to the amount of time spent in them.

The second type of health effect is acute, consisting of eye, nose and throat irritation, headaches, neurotoxic symptoms such as depression, irritability, and forgetfulness, and general malaise—a group of symptoms often described as "Sick Building Syndrome" (SBS). Although the cause or causes of SBS are unknown, several hypotheses implicate low-level concentrations of VOCs as a possible cause (Berglund, 1982; Molhave, 1984).

Table 5. (Continued)

Sample[a]	Emmission Rate (µg/m²h) Aliphatic and Oxygenated Aliphatic Hydrocarbons	Aromatic Hydrocarbons	Halogenated Hydrocarbons	All Target Compounds
Cement block	-	0.39	0.15	0.54
PVC pipe	-	0.53	-	0.53
Duct insulation	0.13	0.15	-	0.28
Treated metal roofing	-	0.19	0.06	0.25
Urethane sealant	-	0.13	-	0.13
Fiberglass insulation	-	0.08	-	0.80
Exterior mineral board	-	0.03	-	0.03
Interior mineral board	-	-	-	-
Ceiling tile	-	-	-	-
Red clay brick	-	-	-	-
Plastic laminate	-	-	-	-
Plastic outlet cover	-	-	-	-
Joint compound	-	-	-	-
Linoleum tile cement	-	-	-	-

[a]Emission rate for cove adhesive is a minimum value, sample was overloaded. It is estimated that cove adhesive is one of the highest emitters of volatile organics
[b]No detectable emissions

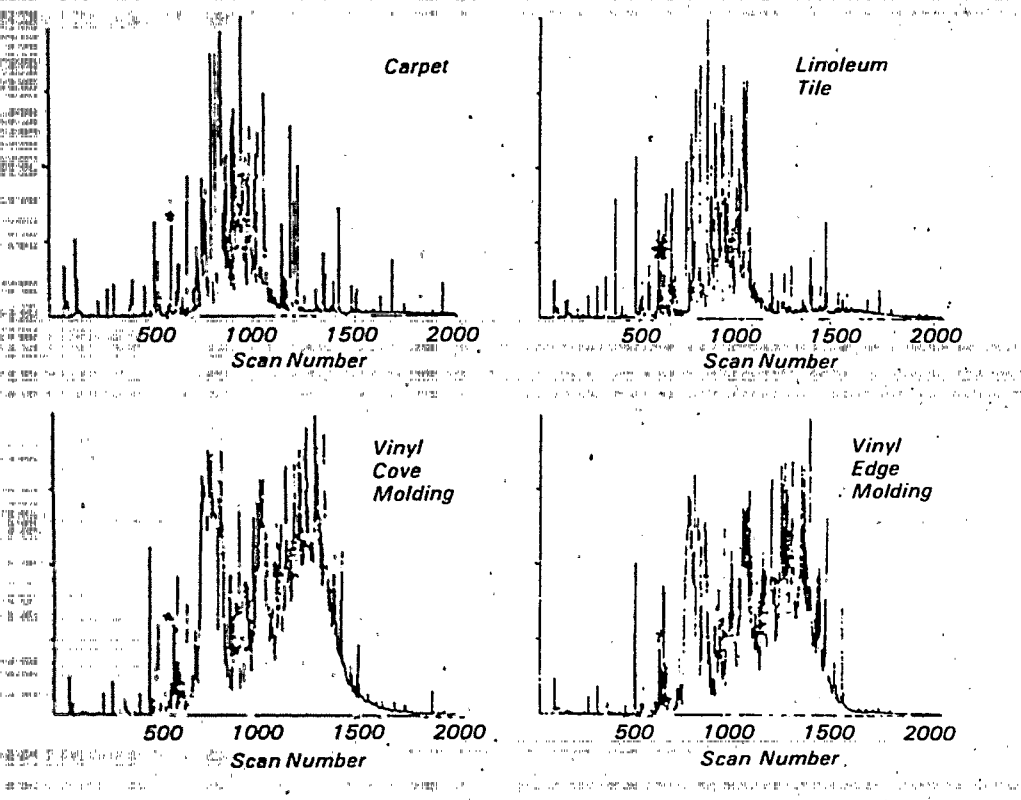

*Figure 1. GC/MS chromatograms of emissions samples collected from interior exposure building materials during headspace experiments (*designates the external standard).*

Conclusions

The measurement method employed for VOCs (sampling on Tenax sorbent followed by GC-MS analysis) was shown to have good precision for nearly all target compounds. Sampling at three different flow rates ("distributed volume" sampling) detected no artifact formation or other sampling problems.

Many volatile organic compounds are at higher concentrations in buildings than outdoors. The sources of these elevated indoor air concentrations include surface coatings, wall and floor coverings, and other building materials. Emission rates ranged up to several thousand µg/m²/h.

Concentrations of individual aromatic and aliphatic compounds such as xylenes and decane were elevated over outdoor levels by factors of 100 or more in the two new buildings studied. The time to reach concentrations comparable with outdoor levels was estimated to be several months.

Concentrations of respirable particulates were elevated in smoking areas of some buildings.

Recommendations

This study of six buildings and its earlier companion study of four buildings has indicated that concentrations of certain target VOCs are elevated in buildings due to emissions from certain building materials. Only ten buildings were monitored and only 50 building materials were tested for emissions. Many more buildings of various types (hospitals, enclosed shopping malls, etc.) where people spend a considerable fraction of their time should be monitored before it will be possible to estimate the frequency distribution of VOC concentrations in such buildings. Many more building materials should be tested to determine their rates of emission of chemicals of concern before a trustworthy estimate of the range of emission rates can be achieved.

Future studies need not employ "distributed volume" sampling on all samples, although limited distributed volume sampling could be employed to assure that sampling problems were not occurring.

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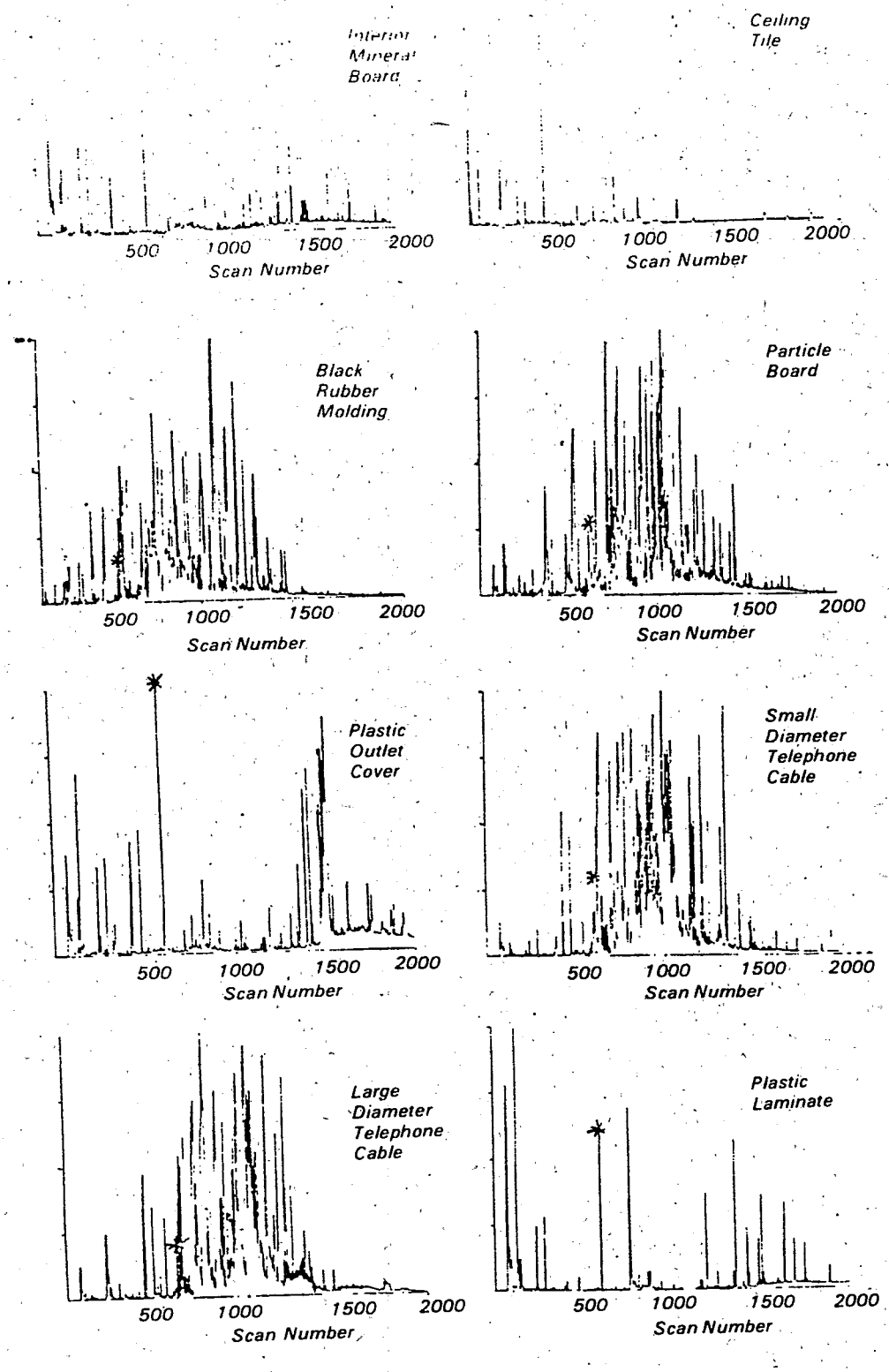

Figure 1. *(Continued)*

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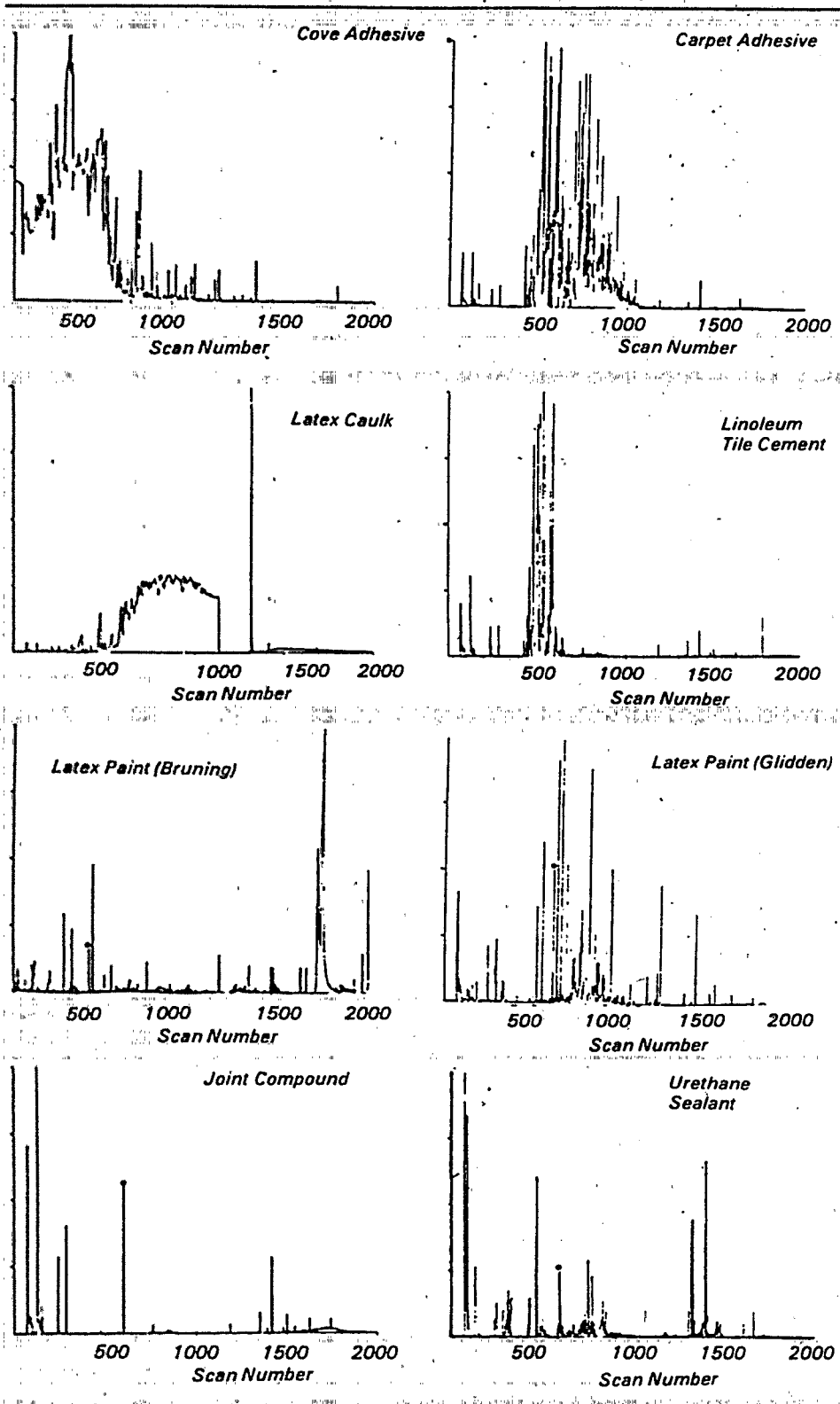

*Figure 2. GC/MS chromatograms of emissions samples collected from solvent based building materials during headspace experiments (*designates the external standard).*

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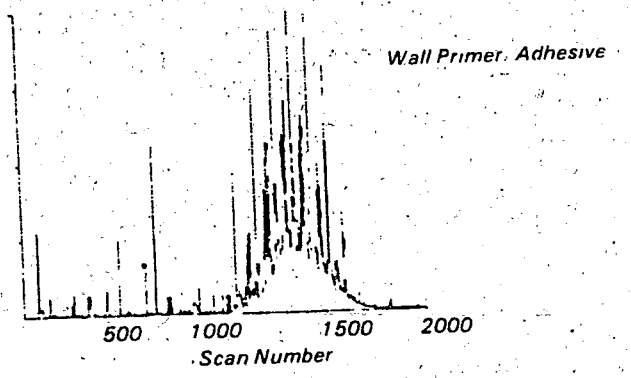

Figure 2. (Continued)

Table 6 Average Air Exchange Measurements for Field Monitoring Trips

Location	Trip	Air Exchange Rate (Changes/h) ± S.D.		
		Overall	Day	Night
New Buildings				
Hospital	1	0.94 ± 0.73	0.93 ± 0.86	0.95 ± 0.64
	2	0.14 ± 0.12	0.19 ± 0.14	0.08 ± 0.08
	3	0.44 ± 0.12	0.50 ± 0.12	0.37 ± 0.08
Office	1	0.60 ± 0.08	0.58 ± 0.08	0.61 ± 0.08
	2	0.30 ± 0.10	0.38 ± 0.07	0.21 ± 0.03
Nursing Home	1	0.54 ± 0.14	0.65 ± 0.10	0.43 ± 0.08
	2	NC[a]	NC	NC
Old Buildings				
Office	1	0.44 ± 0.19	0.49 ± 0.14	0.39 ± 0.23
Office/School	1	0.50 ± 1.10	0.57 ± 0.08	0.45 ± 0.08
Nursing Home	1	0.43 ± .27	0.54 ± 0.33	0.35 ± 0.19

[a]Not calculated.

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The complete report, entitled "Indoor Air Quality in Public Buildings: Volume II," (Order No. PB 89-102 511/AS; Cost: $56.95, subject to change) will be available only from:
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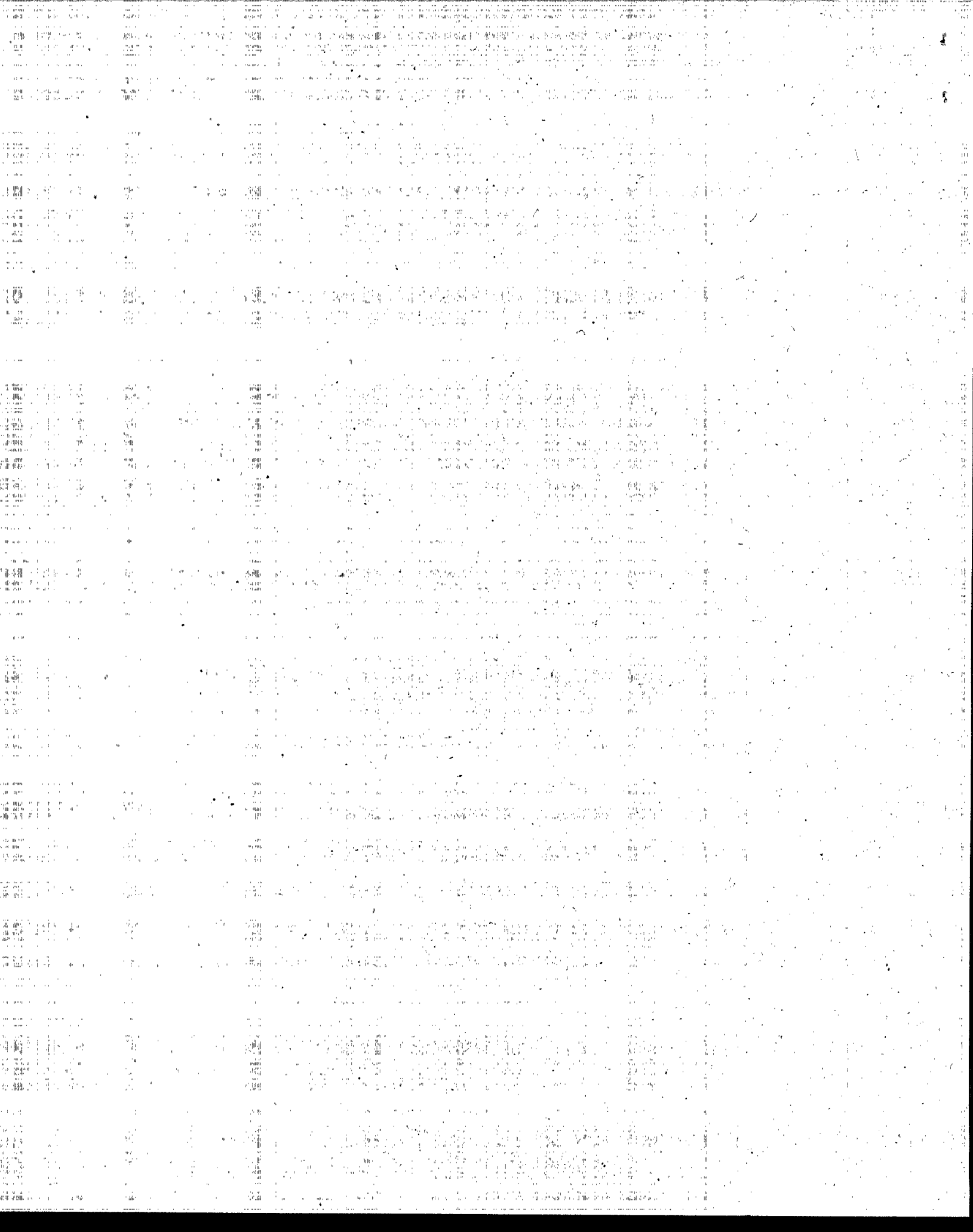

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