



Staten Island/New Jersey Urban Air Toxics Assessment Project Report

Volume IV

Indoor Air

ACKNOWLEDGEMENTS

This report is a collaborative effort of the staffs of the Region II Office of the U.S. Environmental Protection Agency (EPA), the New Jersey Department of Environmental Protection and Energy, the New York State Department of Environmental Conservation, the New York State Department of Health, the University of Medicine and Dentistry of New Jersey and the College of Staten Island. The project was undertaken at the request of elected officials and other representatives of Staten Island concerned that emissions from neighboring industrial sources might be responsible for suspected excess cancer incidences in the area.

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The project was conceived and directed by Conrad Simon, Director of the Air and Waste Management Division, who organized and obtained the necessary federal funding.

Oversight of the overall project was provided by a Management Steering Committee and oversight of specific activities, by a Project Work Group. The members of these groups are listed in Volume II of the report. The Project Coordinators for EPA, Robert Kelly, Rudolph K. Kapichak, and Carol Bellizzi, were responsible for the final preparation of this document and for editing the materials provided by the project subcommittee chairs. William Baker facilitated the coordinators' work.

Drs. Edward Ferrand and, later, Dr. Theo. J. Kneip, working under contract for EPA, wrote several sections, coordinated others, and provided a technical review of the work.

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project organizations via the Management Steering Committee,
whose members are listed in Volume II.

PREFACE - DESCRIPTION OF THE STATEN ISLAND/NEW JERSEY URBAN AIR TOXICS ASSESSMENT PROJECT REPORT

This report describes a project undertaken by the States of New York and New Jersey and the United States Environmental Protection Agency with the assistance of the College of Staten Island, the University of Medicine and Dentistry of New Jersey and, as a contractor, the New Jersey Institute of Technology.

Volume I contains the historical basis for the project and a summary of Volumes II, III, IV, and V of the project report.

Volume II of the report lists the objectives necessary for achieving the overall purpose of the project, the organizational structure of the project, and the tasks and responsibilities assigned to the participants.

Volume III of the report presents the results and discussion of each portion of the project for ambient air. It includes monitoring data, the emission inventory, the results of the source identification analyses, and comparisons of the monitoring results with the results of other studies. Volume III is divided into Part A for volatile organic compounds, and Part B for metals, benzo[α]pyrene (BaP), and formaldehyde. Part B includes the quality assurance (QA) reports for the metals, BaP, and formaldehyde.

Volume IV presents the results and discussion for the indoor air study performed in this project. It contains the QA reports for the indoor air study, and a paper on the method for sampling formaldehyde.

Volume V presents the results of the detailed statistical analysis of the VOCs data, and the exposure and health risk analyses for the project.

Volume VI, in two parts, consists of information on air quality in the project area prior to the SI/NJ UATAP; quality assurance (QA) reports that supplement the QA information in Volume III, Parts A and B; the detailed workplans and QA plans of each of the technical subcommittees; the QA reports prepared by the organizations that analyzed the VOC samples; descriptions of the sampling sites; assessment of the meteorological sites; and a paper on emissions inventory development for publicly-owned treatment works.

The AIRS database is the resource for recovery of the daily data for the project. The quarterly summary reports from the sampling organizations are available on a computer diskette from the National Technical Information Service.

**STATEN ISLAND/NEW JERSEY
URBAN AIR TOXICS ASSESSMENT PROJECT**

Volume IV. INDOOR AIR

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1. BACKGROUND

The New Jersey/Staten Island area which lies on either side of the Arthur Kill represents a highly industrialized and urbanized section of the United States. Many petrochemical industry facilities are located along the Arthur Kill. To address public concern about air quality and possible effects on public health, the U.S. EPA, the states of NY and NJ, and local universities collaborated in the Staten Island/New Jersey Urban Air Toxics Assessment Project (SI/NJ UATAP). Two objectives of the project are to characterize the concentration of organic compounds in the ambient air and to evaluate the risk from inhalation exposure to these compounds. Ambient air sampling has been conducted at sites in New York and New Jersey from October 1987 through September 1989 to characterize exposure to air contaminants in this area.

Many hours of a person's day are spent inside the home. The ambient air can be the most important source of contaminants in indoor air. However, indoor sources can predominate in some circumstances. The indoor air portion of the SI/NJ UATAP project is designed to provide information on the relative importance of indoor air contaminant sources. Indoor air contaminant levels were determined in four homes, concurrently with sampling of contaminant levels at nearby ambient monitoring stations. The residences were selected as not atypical in terms of construction and observable sources of indoor air contaminants. Because there were only a small number of sample locations, the data collected are not representative in the sense of permitting extrapolation to the entire study area. However, the data obtained from this investigation will aid in characterizing the relative risks of indoor and outdoor exposure for those homes tested in the New Jersey/Staten Island area.

2. PURPOSE

The purpose of the indoor air study, as stated in the workplan, was to determine how nearly indoor air contaminant levels in houses near two of the project ambient air monitoring sites correspond to ambient levels at the monitoring stations. If a significant difference between indoor and ambient levels is found, a further purpose was to characterize the difference in terms of exposure for hypothetical residents of these houses.

The indoor air workplan is Appendix A of this report. Frequent reference is made in the report to the individual tasks delineated in the workplan.

3. METHODS

Four homes were selected for indoor air testing according to selection criteria detailed in Task A.2 of the indoor air workplan. Two of the homes are located in Travis, Staten Island, New York (7097-2A and 7097-2B). The other two homes are located in Carteret, New Jersey (0030-B1 and 0030-B2). In addition, outdoor air sampling (ambient air) was conducted at monitoring stations located within a half mile of the selected study homes. The Staten Island outdoor monitor (7097-2C) and the New Jersey outdoor monitor (0030-B3) are monitoring stations previously used in the ambient air monitoring part of this study. Sample collection was conducted in accordance with the procedures specified in Tasks B.3 and B.4.

Three indoor air sampling sites were single family houses. One indoor site was a two-family house. All houses are located in residential neighborhoods in Travis, Staten Island, and Carteret, New Jersey. One home in Travis is approximately 400 feet southeast of the ambient sampling site which is on the roof of PS 26. The other home in Travis is approximately one quarter mile northeast of PS 26. Both homes are two story wood frame structures with full basements. The homes were constructed in 1925 and circa 1900. Air samples were collected in first floor living areas in the locations noted on the floor plans in Appendix B. The ambient air site in Carteret was relocated from the original ambient monitoring site (roof of the police station) to the roof of Carteret High School because subcommittee staff were unable to secure participation by occupants of homes meeting the workplan selection criteria for indoor air sampling sites within one half mile of the police station. One Carteret home is about one half mile south of the high school. The other home is approximately one half mile west of the high school. One home is a two-story wood frame structure with a full basement. The other home is a two story split level wood frame structure. The lower level is a finished living space. Air sampling equipment was located in first floor living spaces; see Appendix B for the floor plans. One resident in a Staten Island home was a smoker who agreed not to smoke 12 hours before and during sampling. All other site selection criteria listed in task A.2 of the indoor air workplan were met.

Indoor air and ambient air volatile organic compound (VOC) samples consisted of two consecutive canister samples collected every 12 days for eight months beginning July 10, 1990, and ending March 19, 1991. Collecting two 12-hour samples was consistent with U.S. EPA's Total Exposure Assessment Methodology (TEAM) study design and provided more data than one 24-hour sample. Air samples for VOCs were collected using SUMMA-passivated canisters according to Compendium Method TO-14 (US Environmental Protection Agency, 1988). The canister samplers

were designed and assembled by the NYS Department of Health's Wadsworth Center for Laboratories and Research. The samplers consisted of a stainless steel inlet line, a 7-micron sintered filter for particulate removal, a 0-30 cc/min mass flow controller, digital flow meter readout/power supply, latching solenoid valve, programmable timer, elapsed time meter, vacuum gauge and dual 6-liter canister enclosure. All internal tubing was made from 1/8-inch chromatographic grade stainless steel tubing. All fittings were 316 stainless steel Swagelok fittings.

The outdoor air VOC samplers were located indoors and nylon intake tubes (10 to 20 feet long) were run to the outdoor sampling locations. To avoid sampling dead air space in the nylon tube, a pump operated by a timer drew ambient air through the nylon tube starting one hour before operation of the canister sampler and continued throughout the 24-hour period.

Analyses were conducted at the Wadsworth Center for Laboratories and Research for 13 VOCs. The VOCs were selected based on the results of ambient air monitoring conducted by other agencies in the SI/NJ UATAP. With the exception of ethylbenzene, all of the 13 VOCs had been detected at PS 26 or Carteret during the second year of ambient monitoring. Detection limits for each of the VOCs are displayed in Table 1. Statistical analysis of the data was conducted using Systat software (Wilkinson, 1990).

Collection of air samples for formaldehyde at the two ambient air sites and two of the indoor sites (one in NY and one in NJ) was planned for the same days that VOC samples were collected. Sampling equipment was received in November 1990; sample collection began December 1, 1990, at the ambient sites and January 6, 1991, at the indoor sites. Ten sampling days were planned for the ambient sites and seven sampling days were planned for the indoor sites. The sampling schedule is given in Table 2. The sampling cartridge contained 2,4-dinitrophenylhydrazine-coated silica. A potassium iodide-coated denuder section preceded the cartridge to preclude a negative bias caused by ozone interference. Three cartridges were used for each 24-hour sampling period: one 24-hour and two consecutive 12-hour cartridges (with switching for the latter two controlled by a timer). Sampling and analysis methodology are described in Appendix C.

Radon air samples were collected at the four indoor and two ambient monitoring sites. The radon sampler was an ion chamber containing a permanently charged electret (an electrostatically charged disk of Teflon). The electret collects ions formed in the chamber by radiation emitted from radon decay products. Long term E-Perm monitors were installed at the ambient sites for a three month sampling period beginning on August 14, 1990. Short-term E-Perm monitors were installed at each of the four indoor

air sites beginning on August 14, 1990; two monitors were installed in each house, with the two monitors in different rooms. Short-term radon monitors were changed whenever an air canister was changed at an indoor sampling site. Sampling periods were planned for 7 to 14 days depending on the schedule for VOC sampling trips. A total of 128 samples was planned (8 samples for each of 16 sampling periods). Radon measurement ended March 6, 1991. Table 3 shows the indoor radon sampling schedule.

Weather data were collected in Staten Island with a Climatronic Electronic Weather Station mounted on the roof of PS 26. Wind speed, wind direction and temperature data were collected for the entire sampling period. Weather data are listed in Appendix D.

4. RESULTS AND ANALYSIS FOR VOCs

Indoor air contaminant concentrations were determined at the four study homes and the two ambient monitoring stations according to the sampling scheme described in objectives B and C of the workplan. Due to occasional equipment failure, laboratory difficulties, and/or technical interferences, the number of analyses conducted for a particular VOC at a specific site varied from 26 to 44. The frequency of detection of a compound above the quantifiable limit (detection limit) for each of the VOCs at the six sites is shown in Table 4. The frequency of detection gives an indication of the prevalence of the VOC at a location over the sampling period. Analytical results for each location are provided in a separate report (NYSDOH, 1991). The Quality Assurance data and discussion are provided in Appendix E.

The VOCs which were frequently detected (75% or more samples) in the indoor air of NY and NJ homes were chloromethane, dichloromethane, hexane, benzene, toluene, ethylbenzene, m,p-xylene and o-xylene. 1,1,1-Trichloroethane was frequently detected in NJ homes (92 to 95%) but less frequently detected in NY homes (70 to 73%). Less often detected were chloroform (53 to 61%), trichloroethylene (3 to 76%) and tetrachloroethylene (20 to 45%). Carbon tetrachloride was never detected indoors.

Many of the VOCs, including chloromethane, dichloromethane, benzene, toluene, m,p-xylenes and o-xylene, were detected frequently in ambient air, also, in both NY and NJ. Hexane and ethylbenzene were frequently detected at the NY monitor and 1,1,1-trichloroethane was frequently detected at the NJ monitor. Notably lower frequencies of detection in ambient air were found for chloroform (0 to 5%), trichloroethylene (3 to 31%) and tetrachloroethylene (11 to 16%). Carbon tetrachloride was never

detected outdoors. These frequency differences are examined quantitatively on a compound-specific basis in the statistical analysis which follows. For values less than the limit of detection, a concentration equal to one-half the detection limit is used for the calculation of means and other statistics. This method is consistent with the statistical procedures used in the ambient air portion of the SI/NJ UATAP. To assess if the change in detection limits during the project affected the calculated means for each analyte, the means were calculated with the non-detects equal to zero, one-half the detection limit, the detection limit, and with the non-detects removed from the sample set. Since all these methods produced similar results for the means, the method used by other study participants is used in this report. The data are presented in Tables 5 through 10. Comparisons of mean indoor and outdoor concentrations for each VOC at a particular location are shown in the bar graph format in Figures 1 through 4.

The ratio of the mean indoor and mean outdoor level of each compound was also calculated for each home. The results are listed in Tables 11A and 11B. The relationships between daily indoor compound concentrations and the corresponding outdoor concentrations were evaluated by the Pearson and Spearman correlation coefficients. The correlation coefficients give an indication of the relationship between two variables. The Pearson correlation coefficient uses the actual values to assess the association between the variables. The Spearman correlation coefficient is a non-parametric test which assigns a rank order to the values and then assesses the relationship between the rank variables. In both procedures, the strength of the association is summarized by the correlation coefficient. The closer the absolute value of the correlation coefficient is to one (unity), the more closely associated are the two variables. The indoor-to-outdoor correlation coefficients for each compound at each home and their respective mean ambient concentrations are shown in Tables 11A and 11B.

In this report, each 12-hour sample was considered to be a separate data point in calculating sample statistics and making tests of significance. An alternative approach would be to average the day and night samples collected on the same date and in the same location and use the average as a single data point. When indoor/outdoor ratios are calculated, both methods produce the same results. Paired t-tests were used to compare the mean indoor and corresponding mean outdoor concentrations with each 12-hour sample as a separate data point. Out of 48 comparisons (12 contaminants at 4 homes), 36 indoor means were significantly different from the corresponding outdoor means at $p < 0.05$. The results are shown in Tables 11A and 11B. Using the averages of corresponding day and night samples as single data points, fewer indoor means (29 out of 48) were significantly different from the corresponding outdoor means at $p < 0.05$. Because both methods

produce the same indoor/outdoor ratios and similar statistically significant differences between indoor and outdoor means, the same conclusions could be drawn using either method.

4.1 Frequently-detected VOCs

4.1.1 Aromatic compounds

The aromatic compounds studied in this project include benzene, toluene, xylenes, and ethylbenzene. All were detected frequently both indoors and outdoors. Toluene was ubiquitous in indoor and ambient air samples in this study. The mean indoor toluene concentrations were 12.3 and 10.1 ppb for Staten Island residences and 9.3 and 11.9 ppb for the New Jersey residences. Mean ambient air concentrations for Staten Island and New Jersey were 6.1 and 6.0 ppb, respectively. A comparison of indoor toluene concentrations to the corresponding outdoor toluene concentrations indicates that the indoor concentrations were consistently higher (I/O ratios of mean concentrations range from 1.6 to 2.0). The mean indoor toluene concentrations are significantly different from the corresponding mean outdoor concentrations for all four residences as evaluated by the paired t-test at $p < 0.05$.

In the case of toluene, the Pearson and Spearman correlation coefficients for comparison of the indoor and outdoor values at the four individual homes are all less than 0.5, indicating that there is little association between the outdoor and indoor values (See Tables 11A and 11B). Since the indoor concentrations were consistently higher than outdoor concentrations and the correlations between indoor and outdoor toluene concentrations are low, indoor sources of toluene appear to be present in the residences.

Benzene was detected in most samples for both Staten Island and New Jersey sites in this study. The mean indoor concentrations were 3.0 and 2.5 ppb for the Staten Island residences and 1.3 and 2.2 ppb for the New Jersey residences. Mean ambient air concentrations for Staten Island and New Jersey were 1.7 and 1.4 ppb, respectively. A comparison of indoor benzene concentrations to the corresponding outdoor benzene concentrations indicates that the indoor concentrations were generally higher (I/O ratio of mean concentrations range from 0.9 to 1.7). The mean indoor and outdoor benzene concentrations are significantly different for three of the four residences studied (indoor benzene in NJ residence 0030-B1 was not significantly different than ambient air monitoring station 0030-B3), as evaluated by the paired t-test at $p < 0.05$.

Evaluation of the relationship between indoor and corresponding outdoor values for benzene reveals Pearson and Spearman correlation coefficients ranging from 0.36 to 0.67. This indicates a weak and variable association between indoor and outdoor benzene concentrations for individual study homes.

In addition to toluene and benzene, the xylenes were also frequently detected. Meta- and para-xylenes (m,p-xylenes) were measured and reported separately from ortho-xylene (o-xylene), although they are related compounds. The mean indoor m,p-xylene concentrations were 6.5 and 3.2 ppb for the Staten Island residences and 4.9 and 2.7 ppb for the New Jersey residences. The ambient air m,p-xylene concentrations for Staten Island and New Jersey monitoring sites were 3.1 and 2.3 ppb, respectively. The I/O ratios ranged from 1.1 to 2.0, indicating consistently higher levels indoors. The differences between indoor and outdoor means were statistically significant (with the exception of NJ residence 0030-B1). The correlation coefficients for the association between indoor and outdoor concentrations ranged from 0.36 to 0.84, indicating a weak-to-moderate association between these variables.

The mean indoor air concentrations of o-xylene were 2.3 and 1.5 ppb for the Staten Island residences and 1.2 and 2.4 ppb for the New Jersey residences. The mean outdoor o-xylene concentrations for Staten Island and New Jersey were 1.4 and 1.1 ppb, respectively. The I/O ratios ranged from 0.95 to 1.5, indicating usually higher o-xylene concentrations indoors. The differences in indoor and outdoor means were significant for o-xylene concentrations for NJ residence 0030-B2 and Staten Island residence 7097-2A. The indoor-outdoor correlation coefficients ranged from 0.05 to 0.83, indicating a very wide range among the four residences. The strongest correlation coefficients (0.55 and 0.83, Pearson and Spearman, respectively) were found for the Staten Island residence 7097-2B, for which the mean indoor concentration was less than the mean outdoor concentration.

Ethylbenzene was detected in most of the air samples collected in this study. The mean indoor concentrations for the Staten Island residences were 1.6 and 1.0 ppb, and for the New Jersey residences were 0.8 and 1.3 ppb. The mean ambient air ethylbenzene concentrations for Staten Island and New Jersey were 0.9 and 0.6 ppb, respectively. The indoor-outdoor ratios ranged from 1.1 to 2.1, indicating consistently higher indoor ethylbenzene concentrations compared to the corresponding outdoor values (all significant differences, $p < 0.05$). The correlation coefficients ranged from 0.22 to 0.74, indicating a wide range but sometimes moderate correlation of indoor and outdoor values.

4.1.2 Halogenated compounds

Among the frequently-detected halogenated compounds, chloromethane and dichloromethane were reported most often. The mean chloromethane concentrations in indoor air were 1.3 and 1.4 ppb in the Staten Island residences, and 0.7 and 0.8 ppb in the New Jersey residences. The mean outdoor concentrations in Staten Island and New Jersey were 0.6 and 0.7 ppb, respectively. The I/O ratios for chloromethane ranged from 1.1 to 2.5, indicating that indoor concentrations were consistently higher than outdoors.

Mean ambient chloromethane concentrations at the Staten Island and New Jersey monitors were nearly equal. The differences between the mean indoor and outdoor concentrations were statistically significant for the Staten Island residences but not for the New Jersey residences. The correlation coefficients ranged widely from 0.05 to 0.51, with the Staten Island houses generally having a weaker association between indoor and outdoor chloromethane concentrations.

Mean dichloromethane concentrations in the Staten Island residences were 0.9 and 3.6 ppb, and for the New Jersey residences were 0.9 and 1.0 ppb. The outdoor dichloromethane concentrations for Staten Island and New Jersey were 1.2 and 2.2 ppb, respectively. For three residential locations, the I/O ratios for dichloromethane levels range from 0.4 to 0.8, indicating lower indoor mean concentrations compared to outdoor mean concentrations. The differences are statistically significant (all $p < 0.05$). Staten Island residence 7097-2B, however, had an I/O ratio of 3.0; the indoor mean was significantly different from the outdoor mean ($p < 0.05$), indicating the likelihood of a strong indoor source. The correlation coefficients for the three residences with low I/O ratios ranged from 0.30 to 0.77, indicating a weak-to-moderate association between indoor and outdoor dichloromethane concentrations. Residence 7097-2B, with an I/O ratio of 3.0, had very low correlation coefficients (0.20 and 0.11, Pearson and Spearman, respectively) further pointing toward the existence of an indoor source of dichloromethane.

1,1,1-Trichloroethane was frequently detected (70% or greater) at all of the indoor and outdoor sampling locations. The mean indoor concentrations for the Staten Island residences were 0.6 and 0.7 ppb and for the New Jersey residences were 2.3 and 1.2 ppb. The mean ambient air concentrations of 1,1,1-trichloroethane for the Staten Island and New Jersey monitors were 0.7 and 2.6 ppb, respectively. The I/O ratios range from 0.5 to 1.0, indicating that mean outdoor air concentrations were consistently equal to or higher than mean indoor air concentrations. The difference between the indoor and outdoor

means was statistically significant for only the New Jersey residence 0030-B2 (I/O ratio of 0.5).

The correlation coefficients for the association between indoor and outdoor 1,1,1-trichloroethane concentrations ranged from 0.07 to 0.79, indicating a broad and inconsistent correlation. The correlation coefficients for New Jersey residence 0030-B2 were extremely low (both 0.07), indicating no association of indoor and outdoor concentrations of 1,1,1-trichloroethane. Since the mean outdoor concentration was twice the mean indoor concentration for this one location and there was no correlation between the indoor and outdoor concentrations, a strong local outdoor source of 1,1,1-trichloroethane may be present.

4.1.3 Other compounds

Hexane was detected frequently (from 66 to 100% of samples) in the air samples collected for this study. The mean indoor air concentrations for the Staten Island residences were 2.0 and 2.5 ppb, and for the New Jersey residences were 0.7 and 1.6 ppb. The mean ambient air concentrations for Staten Island and New Jersey were 1.2 and 0.8 ppb, respectively. Indoor/outdoor ratios ranged from 0.9 to 2.1, indicating generally higher levels indoors. The differences in mean indoor and outdoor concentrations were statistically significant ($p < 0.05$) for all but New Jersey residence 0030-B1 which had the only I/O ratio less than one. Examination of the correlation coefficients reveals relatively high values (0.48 to 0.76), indicating a moderate degree of association between indoor and outdoor hexane concentrations.

4.2 VOCs Detected Less Frequently

Chloroform, trichloroethylene, and tetrachloroethylene were detected indoors and outdoors considerably less often than the other compounds analyzed. Carbon tetrachloride was never detected in any indoor or outdoor air sample in this study.

The mean indoor air concentrations of chloroform for the Staten Island residences were 0.3 and 0.7 ppb, and for the New Jersey residences were 0.3 and 0.6 ppb. It was detected in five percent of ambient samples at the Staten Island monitor (detection limit 0.2 ppb for most samples) and never detected at the New Jersey monitoring site. The highest level was 0.3 ppb. Substituting one-half the detection limit for non-detect values in calculating means, the indoor/outdoor ratios for the four homes ranged from 1.7 to 3.4, indicating consistently higher mean concentrations indoors; the difference in means was significant for every home (all $p < 0.05$). The correlation between indoor

and corresponding outdoor air concentrations for chloroform ranged from 0.22 to 0.51, indicating little correlation between the variables. This is consistent with chlorinated water or some other source of chloroform indoors. Chloroform and other trihalomethanes are present in chlorinated surface water supplies as a result of chlorination and may volatilize when the water is used for showering and other household uses.

Trichloroethylene was detected indoors frequently in the New Jersey residences (52-76%) but infrequently in the Staten Island residences (3-19%). Interestingly, the reverse was found outdoors where the frequency of detecting ambient trichloroethylene was much higher in Staten Island (31%) than in New Jersey (3%). The mean indoor air concentrations of trichloroethylene for the Staten Island residences were 0.2 and 0.2 ppb, and for the New Jersey residences were 0.5 and 1.0 ppb. The mean ambient air concentrations for Staten Island and New Jersey were 0.3 and 0.2 ppb, respectively.

Because the frequencies of detection for trichloroethylene are much lower than the other VOCs investigated, the non-detectable values have greater impact on the calculation of the mean concentrations. The maximum values were similar for three of the homes (about 0.5 to 1.2 ppb); the exception was NJ residence 0030-B1, where a maximum concentration of 4.3 ppb was reached. This is much higher than the highest measured ambient level, which suggests the presence of an indoor source of trichloroethylene in this residence.

Indoor/outdoor ratios for mean trichloroethylene levels ranged widely among the homes. In the Staten Island homes, I/O ratios of 0.56 and 0.74 were found, indicating higher outdoor mean concentrations. The difference in means was significant for one of the homes ($p < 0.05$ for residence 7097-2A). In the New Jersey homes, I/O ratios of 2.3 and 5.1 were found, indicating higher indoor mean concentrations. The differences in the indoor and outdoor means were significant ($p < 0.05$) for both residences. The correlation coefficients were generally weak (0.33 to 0.55) for comparisons of indoor and outdoor trichloroethylene levels for both Staten Island and New Jersey residences.

Tetrachloroethylene was detected more often indoors (20-42%) than outdoors (11-16%) in this study. Mean indoor tetrachloroethylene concentrations for the Staten Island residences were 0.3 and 0.4 ppb, and for the New Jersey residences were 0.5 and 0.5 ppb. The ambient tetrachloroethylene concentrations for Staten Island and New Jersey were 0.4 and 0.3 ppb, respectively. Indoor/Outdoor ratios of mean concentrations ranged from 0.83 to 1.9, indicating a general tendency for higher indoor concentrations. The differences in mean concentrations were statistically significant ($p < 0.05$) except for Staten

Island residence 7097-2A, which had an I/O ratio of 0.83 (the others were greater than 1). The correlation coefficients ranged from 0.09 to 0.88, indicating an extremely wide variability. The higher correlation coefficients (0.78 to 0.88) occurred in the Staten Island homes.

4.3 Data Outliers

In four indoor air samples, the concentration of from one to three compounds were clearly elevated. These "outliers" were omitted from the data set in calculating means and correlation coefficients, since they appeared to be a result of an unusual activity in the home. In two instances, the homeowner reported using a spot remover several days before sampling. In the other two cases, use of a pine cleaner was reported. The locations, dates and concentrations of the outlier data are shown in Table 12.

4.4. Comparison to the Results of Other Studies

Tables 13A and 13B compare ambient data collected at PS 26 in Staten Island and Carteret High School in NJ by the NYS Department of Health from 7/90 to 3/91 to data collected at PS 26 and the Carteret fire station during the same months of the second year (10/88 to 9/89) of the SI/NJ UATAP. The SI/NJ UATAP data collected during the quarter beginning 4/89 are not included so data collected during the same seasons can be compared. NYSDOH detection limits for chloroform, carbon tetrachloride, trichloroethylene and tetrachloroethylene were higher than the detection limits reported by SI/NJ UATAP. These four compounds were not detected in enough NYSDOH samples to make valid comparisons. For all of the other chemicals, the mean of the 1990-1991 NYSDOH results at PS 26 were higher than the 1988-1989 mean values reported by the SI/NJ UATAP. Ratios of NYSDOH means to SI/NJ UATAP means ranged from 1.3 to 3.1. Mean values for hexane and benzene at Carteret High School were lower than the mean values reported by the SI/NJ UATAP. Mean NYSDOH values for all other chemicals at Carteret High School were higher than the mean values reported by SI/NJ UATAP. Ratios of NYSDOH means to SI/NJ UATAP means ranged from 0.7 to 4.5.

Table 14 compares the data from the four indoor sites to indoor air data collected in the Total Exposure Assessment Methodology (TEAM) Study conducted by the U.S. EPA (1987). The TEAM study data presented in Table 14 were collected in Elizabeth and Bayonne, NJ, with personal monitors used to collect twelve-hour overnight samples. Carbon tetrachloride and tetrachloroethylene in all homes and trichloroethylene in the two

Staten Island homes were not detected in enough samples to make valid comparisons. The mean values for trichloroethylene in one home and o-xylene in two homes were above the range of means reported in the TEAM study. Mean values for all other compounds were within or below the range of means reported in the TEAM study.

Table 14 also shows data from the EPA's National Ambient Volatile Organic Compounds (VOCs) Database Update (Shah and Heyerdahl, 1988). The VOCs database combines data from many different indoor air studies in the U.S. and includes data on residential, office, and personal air. Since these data were assembled from studies with different locations, sampling times, sampling methods and analytical techniques, the VOCs database is best used as a screening tool. The mean values of chloroform, 1,1,1-trichloroethane, trichloroethylene, ethylbenzene, m,p-xylenes, and o-xylene for all homes in this study were less than the mean concentrations in the VOCs database. The mean values for hexane and toluene for all homes in this study were higher than the mean concentrations in the VOCs database.

The sampling methods, locations, analytical methods, laboratories and objectives were different for this study, the TEAM study and the studies in the VOCs database. Despite these differences, the data show fairly similar concentrations.

5. RESULTS FOR FORMALDEHYDE

There were several problems with the formaldehyde sampling equipment which interfered with the planned sampling. Residents at two indoor air sites refused sample collection because the samplers were too loud. The sampler overheated at one of the indoor sites, causing it to turn off before the end of a 24-hour sampling period. The resident in the indoor site reported that she did not hear the sampler run during a sampling period. On three occasions, the timer turned the sampler on one week after the sample collection, causing additional air to be sampled. The samplers had no elapsed time indicator to show that the sample had actually been collected for the appropriate length of time. Because of the combination of problems, the samplers were removed from the indoor sites after three sampling dates. The schedule in Table 2 shows the dates and locations of formaldehyde sample collection.

The collocated samples for formaldehyde showed an unacceptable variability. Comparison of the 24-hour samples to an average of the two 12-hour samples showed an average difference of 46%, with differences ranging from 2.3% to 215%. The variability was attributed to out-of-control sampling

equipment. Therefore, the formaldehyde data are not included in the project database.

6. RESULTS, ANALYSIS, AND RISK ASSESSMENT FOR RADON

Four long-term radon samples were collected at the two ambient sites (2 at each site during the same 3-month period). A total of 96 short-term radon samples were collected at the indoor sites according to the schedule in Table 3; 92 of the samples were valid. Indoor radon samples were not collected during three of the planned sampling periods because the monitors were not received from EPA before the sampling trip. The sampling period was extended beyond the planned period for some monitors because the resident was not home on the scheduled day so the monitor could not be picked up until the next sampling trip. Thus, the sampling periods for indoor radon samples varied from 9 to 28 days. Radon measurement results are listed in Appendix F of this volume.

6.1 Radon Data Analysis

The extrapolation of these data to characterize the surrounding community is limited by the small number of houses in the sample. The data include radon measurements in only four houses, two houses in each of two towns. Residential radon levels vary geographically in a non-random fashion. The sample size is therefore, not large enough to establish parameters of radon exposure beyond these four houses. In addition, the houses were not chosen at random, potentially further biasing this sample.

The interpretation of these data is further complicated by the unconventional protocol used during data collection. The measurement protocols used in these tests depart from traditional protocols in several ways. To begin, radon screening protocols usually suggest that at least one measurement be performed in the basement of the structure. If the purpose of the study is to characterize exposure, conventional protocol suggests exposing detectors in areas where residents spend most of their time. Additionally, radon measurement protocols specifically suggest avoiding exposing detectors in bathrooms and kitchens. Though electret detectors such as the type used here are less sensitive to moisture than other types, testing in these rooms may increase the complexity of comparing data to other studies. Furthermore, radon characteristically varies from floor to floor (floor bias). Therefore, in characterizing the radon exposure in an area, most protocols would suggest that measurements in different residences

be made on the same floor so as to be comparable. None of these guidelines was followed consistently in collecting the data in the present study.

The departure from conventional radon collection protocols presents several problems in assuring the validity of the data. For instance, outdoor measurements are made on a roof, not at a height where most people would be exposed, as traditional risk characterization protocols would suggest. Moreover, the source of radon is radium in the ground. As the radium decays, the radon gas is released from the soil, then becomes diluted as it disperses into the atmosphere. Thus, concentrations are expected to be highest nearest the ground and much lower and more variable on a rooftop. Therefore, these readings offer very little information regarding human exposure.

Additionally, the two Travis outdoor measurements are not within acceptable error variability; since one of the two must be assumed to be incorrect, these data offer minimal information. One possible explanation for this result presents itself. Electret detectors such as the type used here must be sufficiently charged to sustain a long-term test of more than 90 days. If the detectors used in these measurements were intended for short-term testing, the electret may not have been sufficiently charged and this factor may have introduced an unpredictable error into the analysis. Secondly, reports from the analytical laboratory suggest poor handling of the detectors during either the sampling or shipping phase. If mishandled, electrets will deliver erroneous readings. Poor handling of the electret detectors, therefore, remains a potential source of this variability between the two readings.

Lastly, the wide variations in detector exposure periods initially presented some concern about the relative accuracy of the various measurements. However, expected error for detectors exposed for this period of time to the radon concentrations seen here is approximately $\pm 25\%$, which is not outside the expected error range for these detectors. Therefore, the difference in exposure period of the electrets is not expected to have affected the accuracy of the readings.

6.2 Radon Data Risk Assessment

The data from the present study are insufficient to characterize risk beyond the four houses in which the data were collected. In an attempt to make maximal use of the information offered by the data, the results of this study have been compared to a more extensive data set of the county collected by the New York State Department of Health (NYSDOH, 1990). A total of 166 basement radon measurements was collected in Richmond County, the

site of the present study; these data are summarized in Table 15. The additional risk of death from lung cancer has been calculated for each radon concentration according to the radon risk assessment of the U.S. Environmental Protection Agency (U.S. EPA, 1992). Figure 5 further illustrates the distribution of radon concentrations in this sample.

Table 15 demonstrates that 94% of the homes in the sample have radon concentrations below 4.0 pCi/l¹. Figure 5 further illustrates this point. However, the table also shows that over 80% of the homes in the sample have radon concentrations which represent excess risk levels of greater than 1 in 1000 or 10⁻³ and approximately 9% correspond to excess risk levels of greater than 10⁻².

The radon measurements in the four houses in the present study are consistent with the concentrations seen in the New York State data set; they fall roughly within the 50th to 60th percentile of that sample. In view of this larger data set, there is nothing unexpected about the radon measurements in the four houses in the present study.

7. SUMMARY

The VOCs which were frequently detected (75% or more of samples) in NY and NJ indoor air were chloromethane, dichloromethane, hexane, benzene, toluene, ethylbenzene, m,p-xylenes and o-xylene. 1,1,1-Trichloroethane was frequently detected in NJ homes only.

The VOCs which were less often detected in NY and NJ indoor air were chloroform, trichloroethylene and tetrachloroethylene. 1,1,1-Trichloroethane was less often detected in NY homes. Carbon tetrachloride was never detected indoors.

The VOCs which were frequently detected in NY and NJ ambient air were chloromethane, dichloromethane, benzene, toluene, m,p-xylenes and o-xylene. Hexane and ethylbenzene were frequently detected in NY ambient air only. 1,1,1-Trichloroethane was frequently detected in NJ ambient air only.

The VOCs which were less often detected in NY and NJ ambient air were chloroform, trichloroethylene and tetrachloroethylene. 1,1,1-Trichloroethane was detected less often in NY ambient air.

¹ PicoCuries per liter of air.

Hexane and ethylbenzene were less often detected in NJ ambient air. Carbon tetrachloride was never detected outdoors.

Toluene, benzene, m,p-xylenes, o-xylene, ethylbenzene, chloromethane, hexane, chloroform and tetrachloroethylene were usually or always found at higher concentrations indoors than outdoors.

The results of these analyses are generally in good agreement with the indoor sampling results of the TEAM study and the VOCs database, and the two-year ambient air sampling portion of the SI/NJ UATAP.

Elevated concentrations of toluene, benzene, m,p-xylenes, o-xylene, ethylbenzene, chloromethane, hexane, chloroform and tetrachloroethylene in indoor air should be evaluated in overall health risk assessments.

The radon concentrations in the four houses in this study are consistent with the concentrations seen in a larger data set for a New York State study of Staten Island; they fall roughly within the 50th to 60th percentile of that sample.

8. ACKNOWLEDGEMENTS

This document is the result of efforts by many people within the New York State Department of Health. Stan House and Bettsy Prohonic conducted the air sampling. Kenneth Aldous and Robert Parillo analyzed the VOCs samples. Judith Schreiber, Carol Meyer, and Greg Smead prepared the report. Charles Hudson and Mark Knudsen coordinated the project. For the radon portion of the study, Larainne Koehler of the U.S. Environmental Protection Agency Region II provided oversight of sampling and data reporting; Michael Buccigrossi and Angela Short analyzed the data and prepared the results and discussion of the radon data.

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Tables and Figures

TABLE 1

Detection Limits

	7/10/90-10/2/90		10/14/90-3/19/91	
	mcg/m ³	ppb	mcg/m ³	ppb
chloromethane	2	1.0	0.4	0.2
dichloromethane	2.8	0.8	0.7	0.2
hexane	3.5	1.0	0.7	0.2
chloroform	3.8	0.8	1	0.2
1,1,1-trichloroethane	4.7	0.9	1.1	0.2
carbon tetrachloride	5.4	0.9	1.2	0.2
benzene	2.4	0.8	0.6	0.2
trichloroethylene	5.3	1.0	1.1	0.2
toluene	NA	NA	NA	NA
tetrachloroethylene	6.2	0.9	1.5	0.2
ethylbenzene	4.3	1.0	0.9	0.2
m,p-xylene	7.9	1.8	1.8	0.4
o-xylene	3.5	0.8	1	0.2

NA = Not Available

mcg/m³ = micrograms per cubic meter

ppb = parts per billion

TABLE 2
SI/NJ UATAP
 Formaldehyde Sampling Schedule

<u>DATE</u>	<u>LOCATION</u>	<u>COMMENT</u>
12/ 1/90	0030-B3 7097-2C	
12/13/90	0030-B3 7097-2C	Sampler also ran on 12/20/90 Sampler also ran on 12 20/90
12/25/90	0030-B3 7097-2C	
1/ 6/91	0030-B3 0030-B1 7097-2C 7097-2B	Sampler also ran on 1/13/91
1/18/91	0030-B3 0030-B1 7097-2C	
1/30/91	0030-B3 0030-B1 7097-2C 7097-2B	Sampler overheated and shut off Resident did not hear sampler run
2/11/91	0030-B3 7097-2C	
2/23/91	0030-B3 7097-2C	
3/7/91	0030-B3 7097-2C	
3/19/91	0030-B3 7097-2C	

TABLE 3
SI/NJ UATAP
Indoor Radon Sampling Schedule

Dates	Length of Sampling Time (Days)	Number of Samples Collected	Number of Samples Planned
8/14/90 - 8/23/90	9	8	8
8/23/90 - 9/06/90	14	8	8
9/06/90 - 9/27/90	13	0	8
9/27/90 - 10/10/90	13	6	8
10/10/90 - 10/23/90	13	8	8
10/23/90 - 11/01/90	9	6	8
10/23/90 - 11/15/90	23	2	0
11/01/90 - 11/15/90	14	4	8
11/01/90 - 11/29/90	28	2	0
11/15/90 - 11/29/90	14	6	8
11/29/90 - 12/11/90	12	8	8
12/11/90 - 12/20/90	9	8	8
12/20/90 - 1/03/91	14	6	8
12/20/90 - 1/17/91	28	2	0
1/03/91 - 1/17/91	14	6	8
1/17/91 - 1/24/91	7	0	8
1/24/91 - 2/07/91	14	8	8
2/07/91 - 2/21/91	14	0	8
2/21/91 - 3/06/91	13	6	8
2/21/91 - 3/21/91	28	2	0
		—	—
		96	128

TABLE 4
Frequencies of Detection, %

Compound	New Jersey			New York		
	Indoor 0030-B1	Indoor 0030-B2	Ambient 0030-B3	Indoor 7097-2A	Indoor 7097-2B	Ambient 7097-2C
chloromethane	79	81	81	91	82	83
dichloromethane	85	84	84	85	94	93
hexane	76	94	66	94	100	89
chloroform	58	61	0	53	60	5
1,1,1-trichloroethane	95	92	84	70	73	73
carbon tetrachloride	0	0	0	0	0	0
benzene	90	95	89	100	100	95
trichloroethylene	76	52	3	3	19	31
toluene	100	100	100	100	100	100
tetrachloroethylene	45	42	11	20	30	16
ethylbenzene	82	84	72	97	79	78
m,p-xylene	91	90	87	100	87	86
o-xylene	87	89	79	97	86	89

frequency of detection = $\frac{\# \text{ of samples with detectable concentration}}{\text{total \# of samples for that location}}$

TABLE 5

Results of Indoor Air Analyses for
Residence 7097-2A, Staten Island

Compound	No. of Samples	% Pos.	Range,ppb	Mean,ppb	SD, ppb
chloromethane	32	91	ND - 2.9	1.3	0.6
dichloromethane	40	85	ND - 2.9	0.9	0.7
hexane	32	94	ND - 7.7	2.5	1.8
chloroform	40	53	ND - 0.9	0.3	0.2
1,1,1-trichloroethane	40	70	ND - 2.0	0.6	0.4
carbon tetrachloride	40	0	ND	-	-
benzene	40	100	0.5 - 7.8	3.0	1.5
trichloroethylene	32	3	ND - 0.5	0.2	0.2
toluene	40	100	3.9 -41.8	12.3	7.6
tetrachloroethylene	40	20	ND - 1.2	0.3	0.2
ethylbenzene	32	97	ND - 4.4	1.6	1.0
m,p-xylene	32	100	2.3 -17.2	6.5	3.8
o-xylene	40	97	ND - 5.8	2.3	1.4

SD = standard deviation

ND = not detected

Mean calculated using one half the detection level for values below the limit of detection.

TABLE 6
Results of Indoor Air Analyses for
Residence 7097-2B, Staten Island

Compound	No. of Samples	% Pos.	Range,ppb	Mean,ppb	SD, ppb
chloromethane	26	82	ND - 3.5	1.4	0.8
dichloromethane	30	94	ND -12.9	3.6	2.6
hexane	26	100	0.7 - 8.6	2.0	1.9
chloroform	30	60	ND - 4.0	0.7	0.7
1,1,1-trichloroethane	30	73	ND - 1.9	0.7	0.4
carbon tetrachloride	30	0	-	-	-
benzene	30	100	0.7 - 7.2	2.5	1.6
trichloroethylene	26	19	ND - 0.5	0.2	0.2
toluene	30	100	3.2 - 34.2	10.1	8.0
tetrachloroethylene	30	30	ND - 1.6	0.4	0.4
ethylbenzene+	24	79	ND - 2.3	1.0	0.7
m,p-xylene+	24	87	ND - 9.5	3.2	2.6
o-xylene+	28	86	ND - 4.7	1.5	1.2

SD = standard deviation

ND = not detected

Mean calculated using one half the detection level for values below the limit of detection

+ = excludes two samples considered outliers

TABLE 7

Results of Ambient Air Analyses for
Monitoring Site 7097-2C, Staten Island

Compound	No. of Samples	% Pos.	Range,ppb	Mean,ppb	SD, ppb
chloromethane	36	83	ND - 1.2	0.6	0.2
dichloromethane	44	93	ND - 3.2	1.2	0.8
hexane	36	89	ND - 3.4	1.2	0.8
chloroform	44	5	ND - 0.3	0.2	0.1
1,1,1-trichloroethane	44	73	ND - 2.8	0.7	0.6
carbon tetrachloride	44	0	ND	-	-
benzene	44	95	ND - 5.0	1.7	1.1
trichloroethylene	36	31	ND - 1.2	0.3	0.3
toluene	44	100	1.3 - 31.6	6.1	5.4
tetrachloroethylene	44	16	ND - 2.8	0.4	0.5
ethylbenzene	36	78	ND - 5.3	0.9	1.1
m,p-xylene	36	86	ND -21.6	3.1	4.3
o-xylene	44	89	ND - 9.5	1.4	1.7

SD = standard deviation

ND = not detected

Mean calculated using one half the detection level for values below the limit of detection.

TABLE 8

Results of Indoor Air Analyses for
Residence 0030-B1, New Jersey

Compound	No. of Samples	% Pos.	Range,ppb	Mean,ppb	SD,ppb
chloromethane	34	79	ND - 1.4	0.7	0.2
dichloromethane	40	85	ND - 7.6	0.9	1.1
hexane	34	76	ND - 2.8	0.7	0.6
chloroform	40	58	ND - 0.9	0.3	0.2
1,1,1-trichloroethane+	39	95	ND -15.0	2.3	2.6
carbon tetrachloride	40	0	ND	-	-
benzene	40	90	ND - 6.9	1.3	1.1
trichloroethylene	34	76	ND - 4.3	1.0	0.9
toluene	40	100	2.9 - 24.2	9.3	4.3
tetrachloroethylene	40	45	ND - 2.2	0.5	0.5
ethylbenzene	34	82	ND - 1.9	0.8	0.5
m,p-xylene	34	91	ND - 7.4	2.7	1.8
o-xylene	40	87	ND - 2.8	1.2	0.7

SD = standard deviation

ND = not detected

Mean calculated using one half the detection level for values below the limit of detection.

+ = excludes one value considered an outlier

TABLE 9

Results of Indoor Air Analyses for
Residence 0030-B2, New Jersey

Compound	No. of Samples	% Pos.	Range, ppb	Mean,ppb	SD,ppb
chloromethane	31	81	ND - 3.2	0.8	0.5
dichloromethane	38	84	ND - 7.4	1.0	1.1
hexane	31	94	ND - 7.1	1.6	1.5
chloroform	38	61	ND - 4.2	0.6	0.7
1,1,1-trichloroethane+	37	92	ND - 3.5	1.2	0.8
carbon tetrachloride	38	0	ND	-	-
benzene	38	95	ND -10.6	2.2	2.0
trichloroethylene	31	52	ND - 1.2	0.5	0.3
toluene	38	100	2.3 -60.5	11.9	11.9
tetrachloroethylene	38	42	ND - 1.9	0.5	0.4
ethylbenzene	31	84	ND - 7.0	1.3	1.5
m,p-xylene	31	90	ND -19.8	4.9	4.8
o-xylene	38	89	ND -12.8	2.4	2.7

SD = standard deviation

ND = not detected

Mean calculated using one half the detection level for values below the limit of detection.

+ = excludes one value considered an outlier

TABLE 10

Results of Ambient Air Analyses for
Monitoring Site 0030-B3, New Jersey

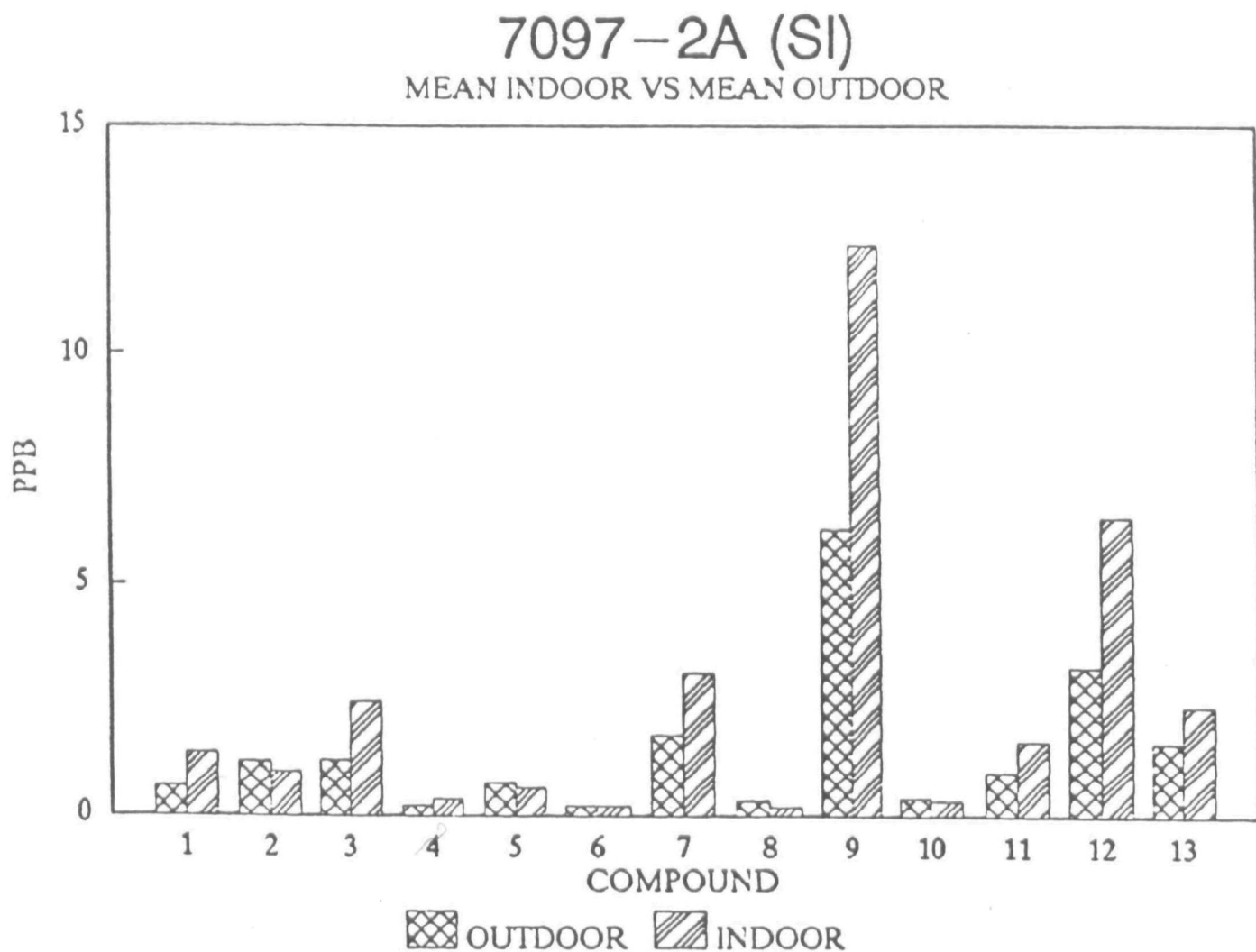
Compound	No. of Samples	% Pos.	Range,ppb	Mean,ppb	SD, ppb
chloromethane	36	81	ND - 1.1	0.7	0.2
dichloromethane	42	84	ND -13.5	2.2	2.8
hexane	36	66	ND - 3.7	0.8	0.8
chloroform	42	0	ND	-	-
1,1,1-trichloroethane	42	84	ND -14.1	2.6	2.5
carbon tetrachloride	42	0	ND	-	-
benzene	42	89	ND - 4.1	1.4	1.0
trichloroethylene	36	3	ND - 0.5	0.2	0.2
toluene	42	100	0.6 -21.8	6.0	4.2
tetrachloroethylene	42	11	ND - 0.7	0.3	0.2
ethylbenzene	36	72	ND - 2.0	0.6	0.4
m,p-xylene	36	87	ND - 7.9	2.3	1.7
o-xylene	42	79	ND - 4.2	1.1	1.0

SD = standard deviation

ND = not detected

Mean calculated using one half the detection level for values below the limit of detection.

Figure 1



Compounds

- | | |
|---------------------------|--------------------------|
| 1 = Chloromethane | 8 = Trichloroethylene |
| 2 = Dichloromethane | 9 = Toluene |
| 3 = Hexane | 10 = Tetrachloroethylene |
| 4 = Chloroform | 11 = Ethylbenzene |
| 5 = 1,1,1-Trichloroethane | 12 = m/p-Xylene |
| 6 = Carbon Tetrachloride | 13 = o-Xylene |
| 7 = Benzene | |

Figure 2

Compounds

- | | |
|---------------------------|--------------------------|
| 1 = Chloromethane | 8 = Trichloroethylene |
| 2 = Dichloromethane | 9 = Toluene |
| 3 = Hexane | 10 = Tetrachloroethylene |
| 4 = Chloroform | 11 = Ethylbenzene |
| 5 = 1,1,1-Trichloroethane | 12 = m/p-Xylene |
| 6 = Carbon Tetrachloride | 13 = o-Xylene |
| 7 = Benzene | |

7097-2B (SI)
MEAN INDOOR VS MEAN OUTDOOR

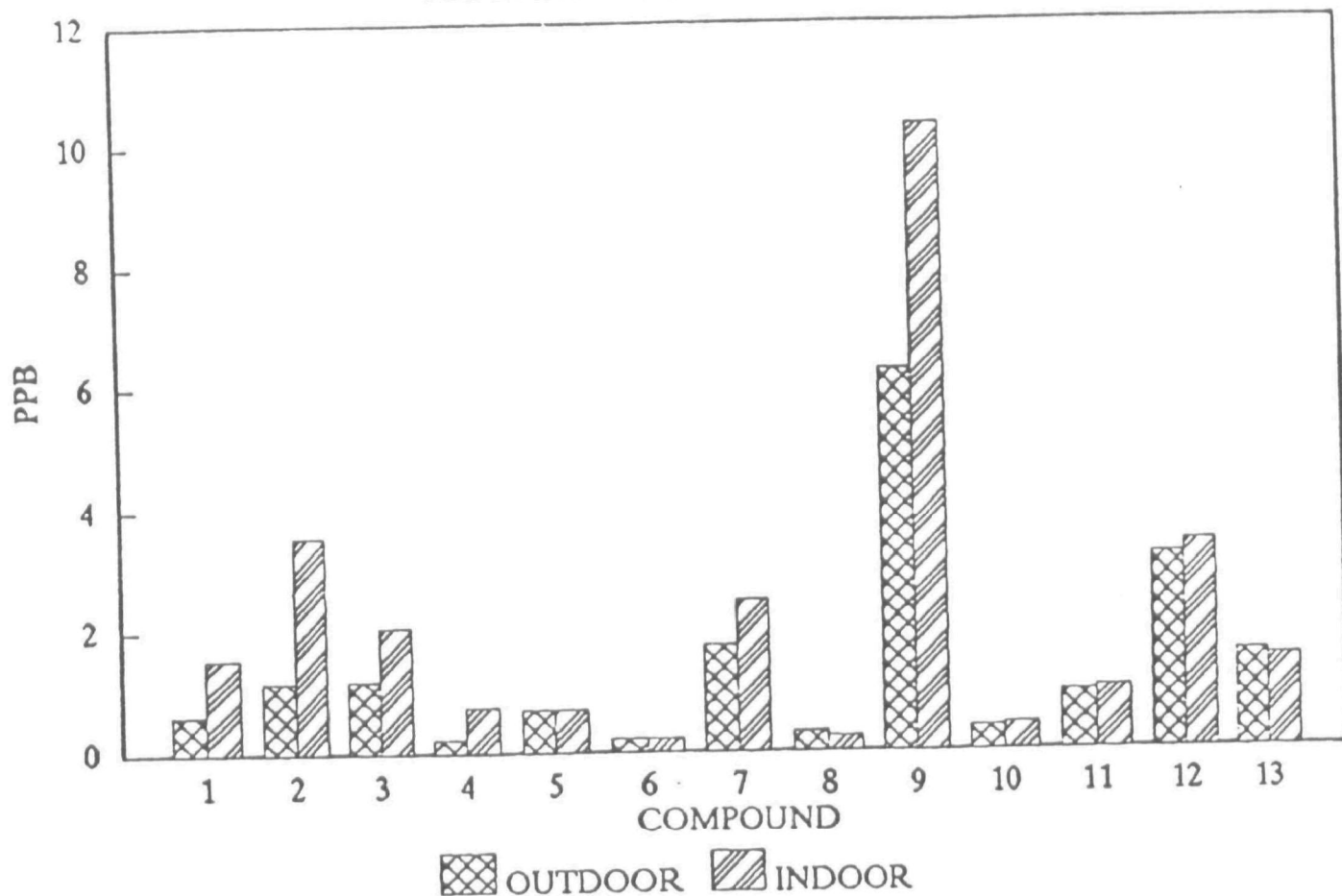


Figure 3

Compounds

- | | |
|---------------------------|--------------------------|
| 1 = Chloromethane | 8 = Trichloroethylene |
| 2 = Dichloromethane | 9 = Toluene |
| 3 = Hexane | 10 = Tetrachloroethylene |
| 4 = Chloroform | 11 = Ethylbenzene |
| 5 = 1,1,1-Trichloroethane | 12 = m/p-Xylene |
| 6 = Carbon Tetrachloride | 13 = o-Xylene |
| 7 = Benzene | |

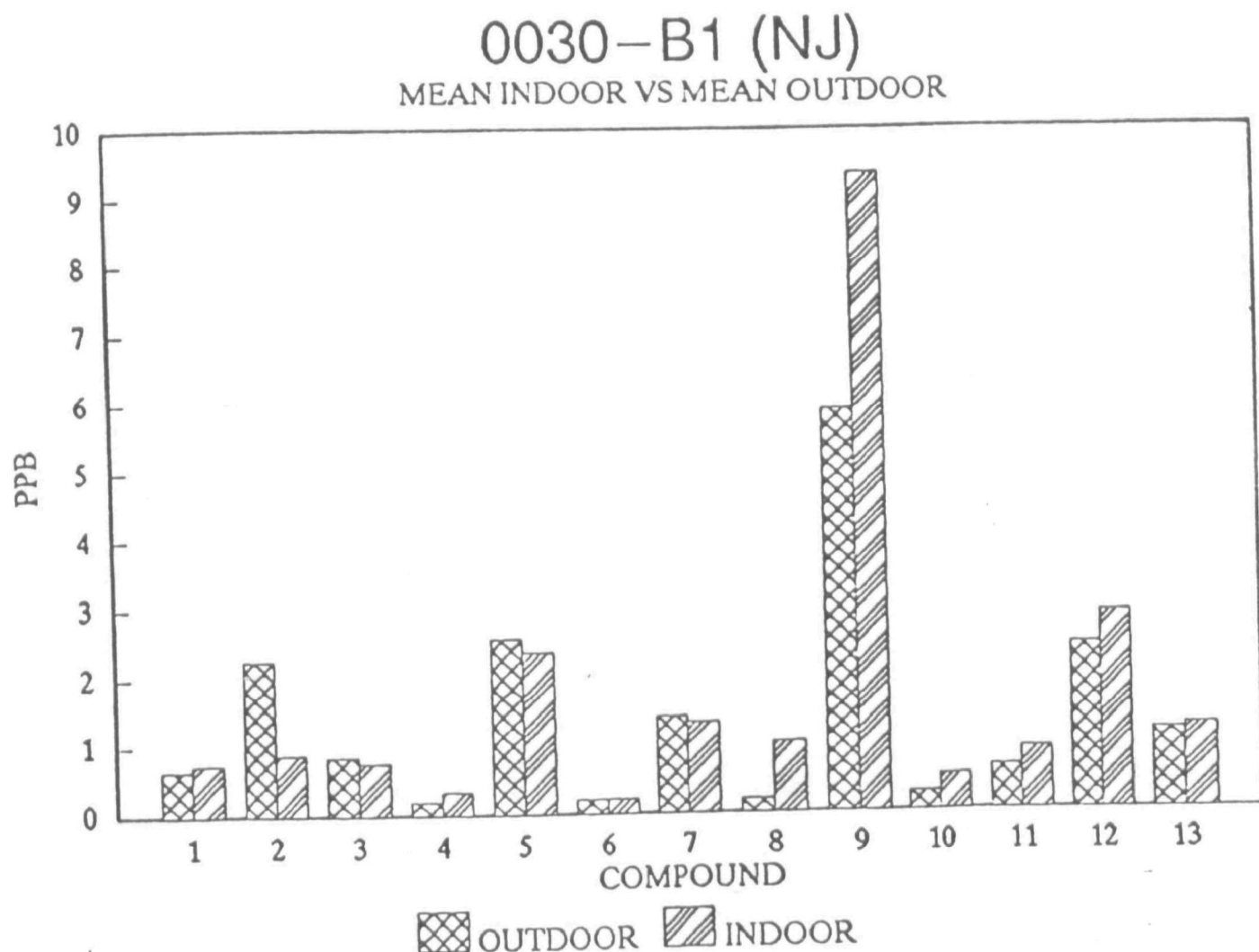
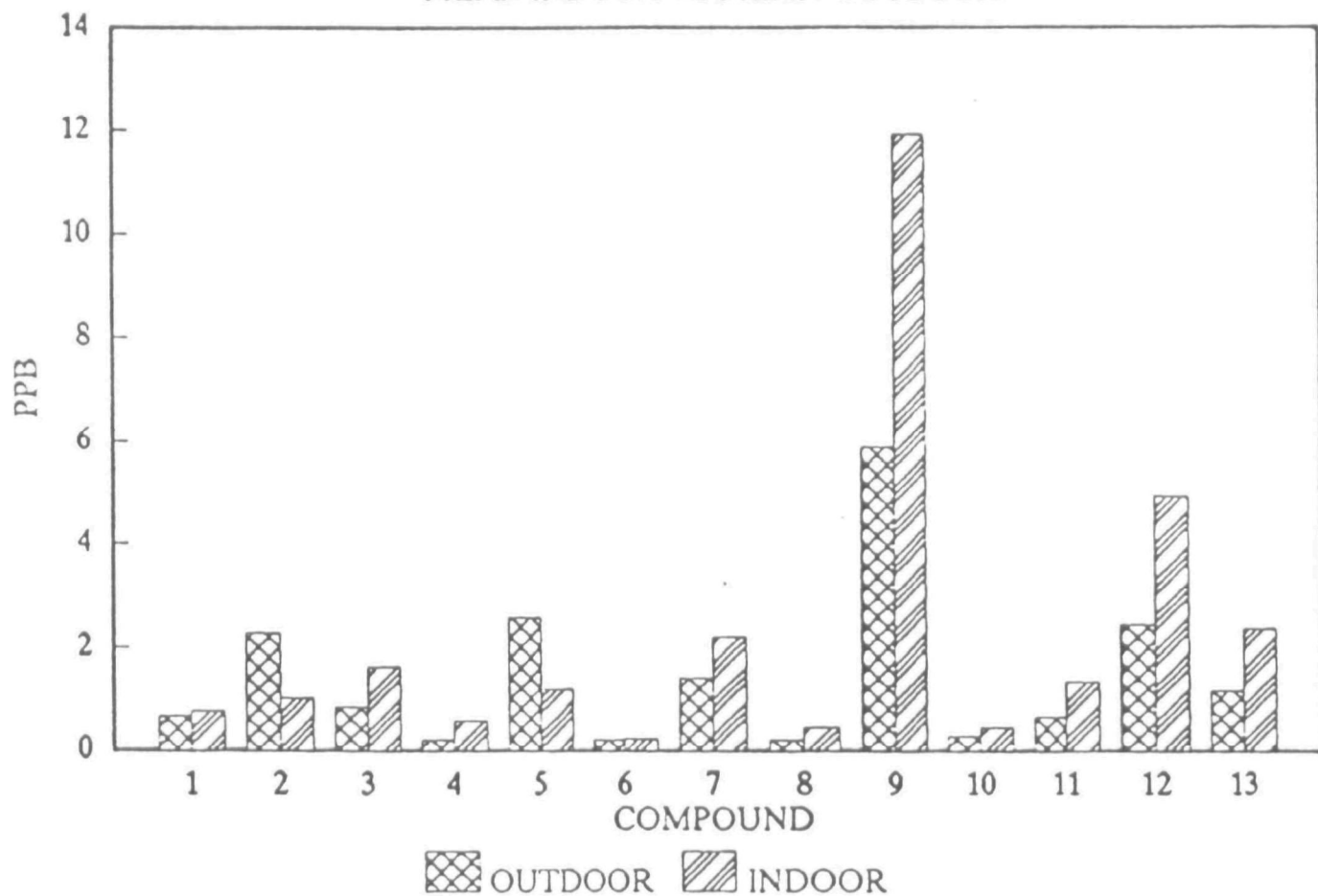


Figure 4

0030-B2 (NJ)
MEAN INDOOR VS MEAN OUTDOOR



Compounds

- | | |
|---------------------------|--------------------------|
| 1 = Chloromethane | 8 = Trichloroethylene |
| 2 = Dichloromethane | 9 = Toluene |
| 3 = Hexane | 10 = Tetrachloroethylene |
| 4 = Chloroform | 11 = Ethylbenzene |
| 5 = 1,1,1-Trichloroethane | 12 = m/p-Xylene |
| 6 = Carbon Tetrachloride | 13 = o-Xylene |
| 7 = Benzene | |

TABLE 11A

Indoor/Outdoor Ratios and Correlation
Coefficients between Indoor Air and Corresponding
Outdoor Air Concentrations

Compound	New Jersey					
	0030-B1			0030-B2		
	I/O	P	S	I/O	P	S
chloromethane	1.1	0.34	0.51	1.2	0.05	0.43
dichloromethane	0.4*	0.33	0.53	0.5*	0.30	0.45
hexane	0.9	0.47	0.63	1.9*	0.54	0.57
chloroform	1.8*	0.50	0.51	2.9*	0.33	0.43
1,1,1-trichloro- ethane	0.9	0.11	0.67	0.5*	0.07	0.07
benzene	0.9	0.65	0.65	1.6*	0.36	0.60
trichloro- ethylene	5.1*	0.33	0.37	2.3*	0.38	0.46
toluene	1.6*	0.12	0.00	2.0*	0.04	0.30
tetrachloro- ethylene	1.9*	0.09	0.37	1.7*	0.61	0.63
ethylbenzene	1.4*	0.54	0.45	2.1*	0.22	0.50
m,p-xylene	1.2	0.47	0.49	2.0*	0.36	0.74
o-xylene	1.1	0.37	0.45	2.0*	0.05	0.53

* = $p < 0.05$

I/O = mean indoor air concentration divided by the corresponding mean outdoor air concentration.

P = Pearson correlation coefficient

S = Spearman correlation coefficient

TABLE 11B

Indoor/Outdoor Ratios and Correlation
Coefficients between Indoor Air and Corresponding
Outdoor Air Concentrations

Compound	Staten Island					
	7097-2A			7097-2B		
	I/O	P	S	I/O	P	S
chloromethane	2.2*	0.26	0.18	2.5*	0.28	0.23
dichloromethane	0.8*	0.77	0.73	3.0*	0.20	0.11
hexane	2.1*	0.76	0.73	1.7*	0.48	0.63
chloroform	1.7*	0.19	0.34	3.4*	0.22	0.28
1,1,1-trichloro- ethane	0.85	0.73	0.64	1.0	0.43	0.11
benzene	1.7*	0.67	0.66	1.4*	0.58	0.35
trichloro- ethylene	0.56*	0.28	0.48	0.74	0.43	0.55
toluene	2.0*	0.09	0.21	1.7*	0.20	0.43
tetrachloro- ethylene	0.83	0.88	0.86	1.1*	0.86	0.78
ethylbenzene	1.7*	0.64	0.68	1.1*	0.74	0.51
m,p-xylene	2.0*	0.51	0.51	1.1*	0.76	0.84
o-xylene	1.5*	0.37	0.40	0.95	0.55	0.83

* = $p < 0.05$

I/O = mean indoor air concentration divided by the corresponding mean outdoor air concentration.

P = Pearson correlation coefficient

S = Spearman correlation coefficient

TABLE 12
List of Data Outliers

Location	Date of Sample	VOC	Outlier Concentration ppb	Usual Range at Location (mean) ppb
7097-2B(SI) ¹	3/19/91D	ethylbenzene	24.8	ND- 2.3, (1.0)
		m,p-xylene	59.8	ND- 9.5, (3.2)
		o-xylene	37.7	ND- 4.7, (1.5)
	3/19/91N	ethylbenzene	24.4	ND- 2.3, (1.0)
		m,p-xylene	60.0	ND- 9.5, (3.2)
		o-xylene	38.2	ND- 4.7, (1.5)
0030-B1(NJ) ²	9/8/90N	1,1,1-trichloroethane	119	ND-15.0, (2.3)
0030-B2(NJ) ³	12/1/90N	1,1,1-trichloroethane	642	ND- 3.5, (1.2)

D = daytime sample

N = night time sample

¹Pine cleaner product was used in home.

²Airwick spot remover may have been used in home.

³Airwick spot remover was used in home.

TABLE 13A

Comparison of Ambient Data
 PS 26 (7097-2C) Staten Island
 NYSDOH (7/90-3/91) to SI/NJ UATAP (10/88-3/89 and 7/89-9/89)

	SI/NJ ^b n	UATAP mean (ppb)	^c n	NYSDOH mean (ppb)	^d ratio	^e difference
chloromethane	NA	NA	36	0.6	-	-
dichloromethane	41	0.93	44	1.2	1.3	+0.3
hexane	NA	NA	36	1.2	-	-
chloroform	41	0.11	44	a	-	-
1,1,1-trichloroethane	41	0.49	44	0.7	1.4	+0.2
carbon tetrachloride	41	0.11	44	a	-	-
benzene	41	1.29	44	1.7	1.3	+0.4
trichloroethylene	26	0.08	36	a	-	-
toluene	41	4.04	44	6.1	1.5	+2.1
tetrachloroethylene	41	0.18	44	a	-	-
ethylbenzene	NA	NA	36	0.9	-	-
m/p-xylene	41	1.47	36	3.1	2.1	+1.6
o-xylene	41	0.45	44	1.4	3.1	+1.0

NA - not available

a - low frequency of detection prevents comparison

b - one 24-hour sample was collected on each sampling day

c - two 12-hour samples were collected on each sampling day

d - ratio equals NYSDOH divided by SI/NJ UATAP

e - difference equals NYSDOH minus SI/NJ UATAP

TABLE 13B

Comparison of Ambient Data
Carteret HS (0030-B3) New Jersey
NYSDOH (7/90-3/91) to SI/NJ UATAP (10/88-3/89 and 7/89-9/89)

	SI/NJ UATAP		NYSDOH			
	^b n	mean (ppb)	^c n	mean (ppb)	^d ratio	^e difference
chloromethane	34	0.28	36	0.7	2.5	+0.4
dichloromethane	NA	NA	42	2.2	-	-
hexane	25	1.09	36	0.8	0.7	-0.3
chloroform	40	0.01	42	a	-	-
1,1,1-trichloroethane	40	0.58	42	2.6	4.5	+2.0
carbon tetrachloride	40	0.11	42	a	-	-
benzene	40	1.54	42	1.4	0.9	-0.1
trichloroethylene	40	0.04	36	a	-	-
toluene	40	4.11	42	6.0	1.5	+1.9
tetrachloroethylene	40	0.14	42	a	-	-
ethylbenzene	NA	NA	36	0.6	-	-
m/p-xylene	40	1.29	36	2.3	1.8	+1.0
o-xylene	40	0.43	42	1.1	2.6	+0.7

NA - not available

a - low frequency of detection prevents comparison

b - one 24-hour sample was collected on each sampling day

c - two 12-hour samples were collected on each sampling day

d - ratio equals NYSDOH divided by SI/NJ UATAP

e - difference equals NYSDOH minus SI/NJ UATAP

TABLE 14

Comparison of Indoor Data
 NYSDOH (7/90-3/91) to other Studies
 Arithmetic Means (ppb)

	NYSDOH 0030-B1	0030-B2	7097-2A	7097-2B	^a EPA Database	^b Team Study Range of Means
chloromethane	0.7	0.8	1.3	1.4	NA	NA
dichloromethane	0.9	1.0	0.9	3.6	NA	NA
hexane	0.7	1.6	2.5	2.0	0.57	NA
chloroform	0.3	0.6	0.3	0.7	0.83	0.64 - 0.95
1,1,1-trichloroethane	2.3	1.2	0.6	0.7	48.9	2.7 - 5.7
carbon tetrachloride	c	c	c	c	0.40	0.20 - 0.21
benzene	1.3	2.2	3.0	2.5	5.16	5.8
trichloroethylene	1.0	0.5	c	c	1.35	0.33 - 0.90
toluene	9.3	11.9	12.3	10.1	0.70	NA
tetrachloroethylene	c	c	c	c	3.06	1.3 - 2.0
ethylbenzene	0.8	1.3	1.6	1.0	2.89	1.1 - 2.6
m/p-xylene	2.7	4.9	6.5	3.2	17.5	2.1 - 6.7
o-xylene	1.2	2.4	2.3	1.5	2.84	0.77 - 2.3

a) Shah and Heyerdahl, 1988

b) U.S. EPA, 1987. Overnight personal air (n = 545 to 553).

c) Low frequency of detection prevents comparisons.

NA - not available.

TABLE 15**RADON DISTRIBUTION AND RISK***

**Data from the New York State Department of Health
Basement Readings Only**

Radon (pCi/l)	Frequency	Percent	Cum Percent	Risk
.1	13	7.8	7.8	.3
.2	18	10.8	18.7	.6
.3	15	9.0	27.7	1.0
.4	14	8.4	36.1	1.3
.5	12	7.2	43.4	1.6
.6	9	5.4	48.8	1.9
.7	7	4.2	53.0	2.2
.8	7	4.2	57.2	2.6
.9	6	3.6	60.8	2.9
1.0	1	.6	61.4	3.2
1.1	6	3.6	65.1	3.5
1.2	7	4.2	69.3	3.8
1.3	3	1.8	71.1	4.2
1.4	3	1.8	72.9	4.5
1.6	1	.6	73.5	5.1
1.7	1	.6	74.1	5.4
1.8	5	3.0	77.1	5.8
1.9	2	1.2	78.3	6.1
2.0	3	1.8	80.1	6.4
2.1	2	1.2	81.3	6.7
2.2	3	1.8	83.1	7.0
2.4	1	.6	83.7	7.7
2.5	2	1.2	84.9	8.0
2.7	2	1.2	86.1	8.6
2.8	1	.6	86.7	9.0
2.9	5	3.0	89.8	9.3
3.0	2	1.2	91.0	9.6
3.1	1	.6	91.6	9.9
3.3	1	.6	92.2	10.6
3.4	1	.6	92.8	10.9
3.9	2	1.2	94.0	12.5
4.1	1	.6	94.6	13.1
4.5	1	.6	95.2	14.4
4.7	1	.6	95.8	15.0
5.0	1	.6	96.4	16.0
6.0	1	.6	97.0	19.2
8.5	2	1.2	98.2	27.2
9.5	1	.6	98.8	30.4
9.8	1	.6	99.4	31.4
11.0	1	.6	100.0	35.2

Total	166	100.0		

* Risk is expressed in terms of
number of excess lung cancer deaths
per 1000 people.

RADON CONCENTRATION
Data from the New York State Department of Health
Basement Readings Only



Quarterly Summaries of the Data

Reduced Data from Canister System
 Agency: NYSDOH
 Pollutant: Methyl Chloride
 Quarter Beginning (Month, Year): July, 1990
 MDL: 1.0 PPB

(Quarterly Report)
 CAS #: 74-87-3
 Till: September, 1990
 Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	6	1.2	0.77	2.6	1.5	0.5	3	
7097-2B	Travis, SI	B	J	6	1.1	0.67	2.0	1.9	0.5	3	
7097-2C	Travis, SI	B	J	6	0.7	0.30	1.2	1.1	0.5	2	
0030-B1	Carteret, NJ	B	J	6	0.7	0.25	1.1	1.0	0.5	2	
0030-B2	Carteret, NJ	B	J	6	1.2	0.96	3.2	1.3	0.5	3	
0030-B3	Carteret, NJ	B	J	6	0.7	0.27	1.1	1.0	0.5	2	

Reduced Data from Canister System
 Agency: NYSDOH
 Pollutant: Dichloromethane
 Quarter Beginning (Month, Year): July, 1990
 MDL: 0.8 PPB

(Quarterly Report)
 CAS #: 75-09-2
 Till: September, 1990
 Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	14	1.3	0.72	2.4	2.3	0.4	10	
7097-2B	Travis, SI	B	J	10	1.7	1.04	3.5	2.9	0.4	8	
7097-2C	Travis, SI	B	J	14	1.9	0.88	3.2	3.2	0.4	12	
0030-B1	Carteret, NJ	B	J	12	1.5	1.93	7.6	2.1	0.4	7	
0030-B2	Carteret, NJ	B	J	13	1.6	1.79	7.4	2.6	0.4	8	
0030-B3	Carteret, NJ	B	J	12	2.1	2.10	7.9	3.5	0.4	7	

Reduced Data from Canister System
 Agency: NYSDOH
 Pollutant: Chloroform
 Quarter Beginning (Month, Year): July, 1990
 MDL: 0.8 PPB

(Quarterly Report)
 CAS #: 67-66-3
 Till: September, 1990
 Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	14	0.4	0.00	0.4	0.4	0.4	0	
7097-2B	Travis, SI	B	J	10	0.4	0.00	0.4	0.4	0.4	0	
7097-2C	Travis, SI	B	J	14	0.4	0.00	0.4	0.4	0.4	0	
0030-B1	Carteret, NJ	B	J	12	0.5	0.16	0.9	0.7	0.4	3	
0030-B2	Carteret, NJ	B	J	13	0.9	0.99	4.2	1.4	0.4	6	
0030-B3	Carteret, NJ	B	J	12	0.4	0.00	0.4	0.4	0.4	0	

Reduced Data from Canister System
 Agency: NYSDOH
 Pollutant: Carbon Tetrachloride
 Quarter Beginning (Month, Year): July, 1990
 MDL: 0.8 PPB

(Quarterly Report)
 CAS #: 56-23-5
 Till: September, 1990
 Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	14	0.4	0.00	0.4	0.4	0.4	0	
7097-2B	Travis, SI	B	J	10	0.4	0.00	0.4	0.4	0.4	0	
7097-2C	Travis, SI	B	J	14	0.4	0.00	0.4	0.4	0.4	0	
0030-B1	Carteret, NJ	B	J	12	0.4	0.00	0.4	0.4	0.4	0	
0030-B2	Carteret, NJ	B	J	13	0.4	0.00	0.4	0.4	0.4	0	
0030-B3	Carteret, NJ	B	J	12	0.4	0.00	0.4	0.4	0.4	0	

Reduced Data from Canister System
 Agency: NYSDOH
 Pollutant: Trichloroethylene
 Quarter Beginning (Month, Year): July, 1990
 MDL: 1.0 PPB

(Quarterly Report)
 CAS #: 79-01-6
 Till: September, 1990
 Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	6	0.5	0.00	0.5	0.5	0.5	0	
7097-2B	Travis, SI	B	J	6	0.5	0.00	0.5	0.5	0.5	0	
7097-2C	Travis, SI	B	J	6	0.5	0.00	0.5	0.5	0.5	0	
0030-B1	Carteret, NJ	B	J	6	0.5	0.00	0.5	0.5	0.5	0	
0030-B2	Carteret, NJ	B	J	6	0.7	0.25	1.1	1.0	0.5	2	
0030-B3	Carteret, NJ	B	J	6	0.5	0.00	0.5	0.5	0.5	0	

Reduced Data from Canister System
 Agency: NYSDOH
 Pollutant: 1,1,1 - Trichloroethane
 Quarter Beginning (Month, Year): July, 1990
 MDL: 0.8 PPB

(Quarterly Report)
 CAS #: 71-55-6
 Till: September, 1990
 Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	14	0.7	0.53	2.0	1.9	0.4	3	
7097-2B	Travis, SI	B	J	10	0.6	0.37	1.6	1.0	0.4	2	
7097-2C	Travis, SI	B	J	14	0.8	0.61	2.2	1.9	0.4	5	
0030-B1	Carteret, NJ	B	J	12	13.8	32.39	120.4	15.2	0.4	10	
0030-B2	Carteret, NJ	B	J	13	1.8	0.95	3.5	3.0	0.4	11	
0030-B3	Carteret, NJ	B	J	12	1.2	0.72	2.6	2.0	0.4	7	

Reduced Data from Canister System
 Agency: NYSDOH
 Pollutant: Perchloroethylene
 Quarter Beginning (Month, Year): July, 1990
 MDL: 1.0 PPB

(Quarterly Report)
 CAS #: 127-18-4
 Till: September, 1990
 Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	14	0.5	0.00	0.5	0.5	0.5	0	
7097-2B	Travis, SI	B	J	10	0.5	0.00	0.5	0.5	0.5	0	
7097-2C	Travis, SI	B	J	14	0.5	0.00	0.5	0.5	0.5	0	
0030-B1	Carteret, NJ	B	J	12	0.5	0.00	0.5	0.5	0.5	0	
0030-B2	Carteret, NJ	B	J	13	0.7	0.48	1.9	1.6	0.5	3	
0030-B3	Carteret, NJ	B	J	12	0.5	0.00	0.5	0.5	0.5	0	

Reduced Data from Canister System
 Agency: NYSDOH
 Pollutant: Hexane
 Quarter Beginning (Month, Year): July, 1990
 MDL: 1.0 PPB

(Quarterly Report)
 CAS #: 110-54-3
 Till: September, 1990
 Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	6	4.1	2.68	7.7	5.4	0.5	4	
7097-2B	Travis, SI	B	J	6	4.3	2.42	8.6	6.3	1.9	6	
7097-2C	Travis, SI	B	J	6	1.8	1.16	3.4	3.1	0.5	4	
0030-B1	Carteret, NJ	B	J	6	0.7	0.25	1.1	1.0	0.5	2	
0030-B2	Carteret, NJ	B	J	6	2.1	2.27	7.1	1.3	0.5	5	
0030-B3	Carteret, NJ	B	J	6	0.8	0.38	1.3	1.3	0.5	2	

Reduced Data from Canister System
 Agency: NYSDOH
 Pollutant: Benzene
 Quarter Beginning (Month, Year): July, 1990
 MDL: 0.8 PPB

(Quarterly Report)
 CAS #: 71-43-2
 Till: September, 1990
 Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	14	3.2	1.88	7.8	5.0	0.5	14	
7097-2B	Travis, SI	B	J	10	2.7	1.88	7.2	5.0	0.7	10	
7097-2C	Travis, SI	B	J	14	2.0	0.97	3.4	3.4	0.4	13	
0030-B1	Carteret, NJ	B	J	12	1.1	0.57	2.3	1.8	0.4	9	
0030-B2	Carteret, NJ	B	J	13	2.9	2.77	10.6	7.5	0.4	12	
0030-B3	Carteret, NJ	B	J	12	1.4	0.85	3.0	2.8	0.4	10	

Reduced Data from Canister System
 Agency: NYSDOH
 Pollutant: Toluene
 Quarter Beginning (Month, Year): July, 1990
 MDL: 0.8 PPB

(Quarterly Report)
 CAS #: 108-88-3
 Till: September, 1990
 Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	14	11.6	6.62	31.6	16.3	3.9	14	
7097-2B	Travis, SI	B	J	10	10.3	8.34	34.2	10.5	3.2	10	
7097-2C	Travis, SI	B	J	14	8.2	3.38	15.8	13.2	3.4	14	
0030-B1	Carteret, NJ	B	J	12	10.0	5.09	24.2	13.7	2.9	12	
0030-B2	Carteret, NJ	B	J	13	13.6	15.46	60.5	31.6	2.3	13	
0030-B3	Carteret, NJ	B	J	12	7.7	5.83	21.8	14.7	2.6	12	

Reduced Data from Canister System
 Agency: NYSDOH
 Pollutant: o-Xylene
 Quarter Beginning (Month, Year): July, 1990
 MDL: 0.8 PPB

(Quarterly Report)
 CAS #: 95-47-6
 Till: September, 1990
 Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	14	2.8	1.55	5.8	4.7	0.4	13	
7097-2B	Travis, SI	B	J	10	1.3	1.00	3.7	2.2	0.4	6	
7097-2C	Travis, SI	B	J	14	1.9	1.29	4.4	3.7	0.4	10	
0030-B1	Carteret, NJ	B	J	12	1.1	0.68	2.8	1.6	0.4	8	
0030-B2	Carteret, NJ	B	J	13	3.3	3.88	12.8	9.8	0.4	10	
0030-B3	Carteret, NJ	B	J	12	1.2	1.29	4.2	3.5	0.4	6	

Reduced Data from Canister System
 Agency: NYSDOH
 Pollutant: p-Xylene, m-Xylene
 Quarter Beginning (Month, Year): July, 1990
 MDL: 1.8 PPB

(Quarterly Report)
 CAS #: 106-42-3, 108-38-3
 Till: September, 1990
 Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	6	10.1	4.09	17.2	12.6	4.7	6	
7097-2B	Travis, SI	B	J	6	2.0	1.22	4.0	3.3	0.9	3	
7097-2C	Travis, SI	B	J	6	2.5	2.21	6.0	5.1	0.9	2	
0030-B1	Carteret, NJ	B	J	6	2.2	1.31	4.4	3.3	0.9	4	
0030-B2	Carteret, NJ	B	J	6	5.3	6.65	19.8	4.7	0.9	4	
0030-B3	Carteret, NJ	B	J	6	2.1	1.48	5.1	2.6	0.9	4	

Reduced Data from Canister System
 Agency: NYSDOH
 Pollutant: Ethylbenzene
 Quarter Beginning (Month, Year): July, 1990
 MDL: 1.0 PPB

(Quarterly Report)
 CAS #: 100-41-4
 Till: September, 1990
 Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	6	2.2	1.17	4.4	2.3	0.5	5	
7097-2B	Travis, SI	B	J	6	0.7	0.36	1.5	0.5	0.5	1	
7097-2C	Travis, SI	B	J	6	0.9	0.62	2.1	1.3	0.5	2	
0030-B1	Carteret, NJ	B	J	6	0.8	0.34	1.3	1.2	0.5	3	
0030-B2	Carteret, NJ	B	J	6	1.7	2.38	7.0	1.0	0.5	2	
0030-B3	Carteret, NJ	B	J	6	0.5	0.00	0.5	0.5	0.5	0	

Reduced Data from Canister System
 Agency: NYSDOH
 Pollutant: Methyl Chloride
 Quarter Beginning (Month, Year): October, 1990
 MDL: 1.0 PPB
 0.2 PPB after Oct. 2, 1990

(Quarterly Report)
 CAS #: 74-87-3
 Till: December, 1990
 Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	14	1.3	0.47	2.1	2.0	0.6	14	
7097-2B	Travis, SI	B	J	10	1.7	0.48	2.4	2.3	0.7	10	
7097-2C	Travis, SI	B	J	16	0.5	0.12	0.8	0.7	0.3	14	
0030-B1	Carteret, NJ	B	J	14	0.8	0.27	1.4	1.1	0.5	12	
0030-B2	Carteret, NJ	B	J	16	0.6	0.21	1.0	0.9	0.1	13	
0030-B3	Carteret, NJ	B	J	16	0.6	0.17	1.1	0.8	0.4	14	

Reduced Data from Canister System
 Agency: NYSDOH
 Pollutant: Dichloromethane
 Quarter Beginning (Month, Year): October, 1990
 MDL: 0.8 PPB
 0.2 PPB after Oct. 2, 1990

(Quarterly Report)
 CAS #: 75-09-2
 Till: December, 1990
 Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	14	0.8	0.68	2.9	1.6	0.1	13	
7097-2B	Travis, SI	B	J	10	3.3	0.88	5.0	4.4	2.1	10	
7097-2C	Travis, SI	B	J	16	0.9	0.56	2.0	1.8	0.3	15	
0030-B1	Carteret, NJ	B	J	14	0.7	0.32	1.6	1.0	0.3	13	
0030-B2	Carteret, NJ	B	J	16	0.7	0.38	1.9	1.3	0.4	15	
0030-B3	Carteret, NJ	B	J	16	2.9	3.96	13.5	12.6	0.4	15	

Reduced Data from Canister System
 Agency: NYSDOH
 Pollutant: Chloroform
 Quarter Beginning (Month, Year): October, 1990
 MDL: 0.8 PPB
 0.2 PPB after Oct. 2, 1990

(Quarterly Report)
 CAS #: 67-66-3
 Till: December, 1990
 Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	14	0.3	0.16	0.6	0.5	0.1	10	
7097-2B	Travis, SI	B	J	10	0.7	0.42	1.6	1.1	0.1	8	
7097-2C	Travis, SI	B	J	16	0.2	0.10	0.4	0.4	0.1	1	
0030-B1	Carteret, NJ	B	J	14	0.3	0.12	0.5	0.4	0.1	9	
0030-B2	Carteret, NJ	B	J	16	0.4	0.46	2.1	0.6	0.1	9	
0030-B3	Carteret, NJ	B	J	16	0.1	0.10	0.4	0.4	0.1	0	

Reduced Data from Canister System
 Agency: NYSDOH
 Pollutant: Carbon Tetrachloride
 Quarter Beginning (Month, Year): October, 1990
 MDL: 0.8 PPB
 0.2 PPB after Oct. 2, 1990

(Quarterly Report)
 CAS #: 56-23-5
 Till: December, 1990
 Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	14	0.1	0.00	0.1	0.1	0.1	0	
7097-2B	Travis, SI	B	J	10	0.1	0.00	0.1	0.1	0.1	0	
7097-2C	Travis, SI	B	J	16	0.1	0.11	0.4	0.4	0.1	0	
0030-B1	Carteret, NJ	B	J	14	0.1	0.12	0.4	0.4	0.1	0	
0030-B2	Carteret, NJ	B	J	16	0.1	0.11	0.4	0.4	0.1	0	
0030-B3	Carteret, NJ	B	J	16	0.1	0.11	0.4	0.4	0.1	0	

Reduced Data from Canister System
 Agency: NYSDOH
 Pollutant: Trichloroethylene
 Quarter Beginning (Month, Year): October, 1990
 MDL: 1.0 PPB
 0.2 PPB after Oct. 2, 1990

(Quarterly Report)
 CAS #: 79-01-6
 Till: December, 1990
 Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	14	0.1	0.05	0.3	0.1	0.1	13	
7097-2B	Travis, SI	B	J	10	0.1	0.08	0.3	0.3	0.1	2	
7097-2C	Travis, SI	B	J	16	0.3	0.22	0.9	0.5	0.1	8	
0030-B1	Carteret, NJ	B	J	14	0.8	0.38	1.3	1.2	0.2	12	
0030-B2	Carteret, NJ	B	J	16	0.5	0.29	1.2	0.9	0.1	11	
0030-B3	Carteret, NJ	B	J	16	0.2	0.13	0.5	0.5	0.1	1	

Reduced Data from Canister System
 Agency: NYSDOH
 Pollutant: 1,1,1 - Trichloroethane
 Quarter Beginning (Month, Year): October, 1990
 MDL: 0.8 PPB
 0.2 PPB after Oct. 2, 1990

(Quarterly Report)
 CAS #: 71-55-6
 Till: December, 1990
 Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	14	0.5	0.26	1.2	0.8	0.1	13	
7097-2B	Travis, SI	B	J	10	0.6	0.18	1.0	0.9	0.5	10	
7097-2C	Travis, SI	B	J	16	0.7	0.62	2.8	1.5	0.2	15	
0030-B1	Carteret, NJ	B	J	14	1.6	1.08	5.2	2.2	0.6	14	
0030-B2	Carteret, NJ	B	J	16	41.4	156.67	648.1	1.8	0.4	15	
0030-B3	Carteret, NJ	B	J	16	2.5	3.12	14.1	3.3	0.3	15	

Reduced Data from Canister System
 Agency: NYSDOH
 Pollutant: Perchloroethylene
 Quarter Beginning (Month, Year): October, 1990
 MDL: 1.0 PPB
 0.2 PPB after Oct. 2, 1990

(Quarterly Report)
 CAS #: 127-18-4
 Till: December, 1990
 Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	14	0.2	0.15	0.6	0.4	0.1	9	
7097-2B	Travis, SI	B	J	10	0.4	0.37	1.1	1.1	0.1	5	
7097-2C	Travis, SI	B	J	16	0.4	0.67	2.8	0.9	0.1	4	
0030-B1	Carteret, NJ	B	J	14	0.7	0.78	2.2	2.1	0.1	8	
0030-B2	Carteret, NJ	B	J	16	0.3	0.26	1.1	0.7	0.1	8	
0030-B3	Carteret, NJ	B	J	16	0.2	0.18	0.7	0.5	0.1	2	

Reduced Data from Canister System
 Agency: NYSDOH
 Pollutant: Hexane
 Quarter Beginning (Month, Year): October, 1990
 MDL: 1.0 PPB
 0.2 PPB after Oct. 2, 1990

(Quarterly Report)
 CAS #: 110-54-3
 Till: December, 1990
 Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	14	2.6	1.08	4.6	4.3	1.3	14	
7097-2B	Travis, SI	B	J	10	1.4	0.45	2.1	2.0	0.7	10	
7097-2C	Travis, SI	B	J	16	1.1	0.52	2.2	1.8	0.5	14	
0030-B1	Carteret, NJ	B	J	14	1.0	0.69	2.8	1.9	0.4	13	
0030-B2	Carteret, NJ	B	J	16	1.7	1.20	5.1	3.4	0.5	15	
0030-B3	Carteret, NJ	B	J	16	0.8	0.58	2.4	1.9	0.2	14	

Reduced Data from Canister System

(Quarterly Report)

Agency: NYSDOH

Pollutant: Benzene

Quarter Beginning (Month, Year): October, 1990

CAS #: 71-43-2

Till: December, 1990

MDL: 0.8 PPB

Units: PPB

0.2 PPB after Oct. 2, 1990

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	14	3.2	1.16	5.6	4.4	1.4	14	
7097-2B	Travis, SI	B	J	10	2.1	0.87	3.8	3.4	1.0	10	
7097-2C	Travis, SI	B	J	16	1.6	0.86	3.4	3.4	0.4	15	
0030-B1	Carteret, NJ	B	J	14	1.3	0.83	3.8	2.1	0.4	13	
0030-B2	Carteret, NJ	B	J	16	1.9	1.12	4.1	4.1	0.4	15	
0030-B3	Carteret, NJ	B	J	16	1.3	0.98	4.1	2.7	0.1	14	

Reduced Data from Canister System

(Quarterly Report)

Agency: NYSDOH

Pollutant: Toluene

Quarter Beginning (Month, Year): October, 1990

CAS #: 108-88-3

Till: December, 1990

MDL: 0.8 PPB

Units: PPB

0.2 PPB after Oct. 2, 1990

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	14	10.6	4.23	20.3	17.1	4.2	14	
7097-2B	Travis, SI	B	J	10	7.9	1.87	10.3	10.3	5.0	10	
7097-2C	Travis, SI	B	J	16	5.9	6.92	31.6	10.0	1.3	16	
0030-B1	Carteret, NJ	B	J	14	10.2	3.62	18.4	15.3	3.9	14	
0030-B2	Carteret, NJ	B	J	16	12.6	10.51	34.2	31.6	2.9	16	
0030-B3	Carteret, NJ	B	J	16	4.4	2.33	10.8	7.4	0.6	16	

Reduced Data from Canister System

(Quarterly Report)

Agency: NYSDOH

Pollutant: o-Xylene

Quarter Beginning (Month, Year): October, 1990

CAS #: 95-47-6

Till: December, 1990

MDL: 0.8 PPB

Units: PPB

0.2 PPB after Oct. 2, 1990

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	14	2.7	1.47	5.8	5.8	1.0	14	
7097-2B	Travis, SI	B	J	10	1.7	1.43	4.7	4.4	0.6	10	
7097-2C	Travis, SI	B	J	16	1.5	2.15	9.5	2.8	0.3	15	
0030-B1	Carteret, NJ	B	J	14	1.4	0.87	2.8	2.8	0.4	13	
0030-B2	Carteret, NJ	B	J	16	2.1	1.89	6.5	5.6	0.4	15	
0030-B3	Carteret, NJ	B	J	16	1.0	0.87	4.0	1.6	0.1	14	

Reduced Data from Canister System
 Agency: NYSDOH
 Pollutant: p-Xylene, m-Xylene
 Quarter Beginning (Month, Year): October, 1990
 MDL: 1.8 PPB
 0.4 PPB after Oct. 2, 1990

(Quarterly Report)
 CAS #: 106-42-3, 108-38-3
 Till: December, 1990
 Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	14	6.8	3.65	15.8	12.6	2.3	14	
7097-2B	Travis, SI	B	J	10	3.9	2.78	9.5	9.1	1.4	10	
7097-2C	Travis, SI	B	J	16	3.3	5.00	21.6	8.1	0.8	15	
0030-B1	Carteret, NJ	B	J	14	3.3	2.12	7.4	6.3	0.9	13	
0030-B2	Carteret, NJ	B	J	16	5.0	4.90	17.2	14.9	0.9	15	
0030-B3	Carteret, NJ	B	J	16	2.2	1.74	7.9	4.2	0.2	14	

Reduced Data from Canister System
 Agency: NYSDOH
 Pollutant: Ethylbenzene
 Quarter Beginning (Month, Year): October, 1990
 MDL: 1.0 PPB
 0.2 PPB after Oct. 2, 1990

(Quarterly Report)
 CAS #: 100-41-4
 Till: December, 1990
 Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	14	1.9	0.97	4.0	3.5	0.5	14	
7097-2B	Travis, SI	B	J	10	1.0	0.65	2.3	2.2	0.5	10	
7097-2C	Travis, SI	B	J	16	1.0	1.23	5.3	2.2	0.1	14	
0030-B1	Carteret, NJ	B	J	14	1.0	0.54	1.9	1.9	0.4	13	
0030-B2	Carteret, NJ	B	J	16	1.3	1.30	4.4	4.2	0.4	15	
0030-B3	Carteret, NJ	B	J	16	0.6	0.37	1.8	0.9	0.1	13	

Reduced Data from Canister System
 Agency: NYSDOH
 Pollutant: Methyl Chloride
 Quarter Beginning (Month, Year): January, 1991
 MDL: 0.2 PPB

(Quarterly Report)
 CAS #: 74-87-3
 Till: March, 1991
 Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	12	1.6	0.58	2.9	2.3	0.7	12	
7097-2B	Travis, SI	B	J	10	1.7	0.82	3.5	2.4	0.3	10	
7097-2C	Travis, SI	B	J	14	0.7	0.09	0.8	0.8	0.6	14	
0030-B1	Carteret, NJ	B	J	14	0.8	0.21	1.1	0.9	0.1	13	
0030-B2	Carteret, NJ	B	J	9	0.8	0.11	0.9	0.9	0.7	9	
0030-B3	Carteret, NJ	B	J	14	0.8	0.08	0.9	0.8	0.6	14	

Reduced Data from Canister System

(Quarterly Report)

Agency: NYSDOH

Pollutant: Dichloromethane

CAS #: 75-09-2

Quarter Beginning (Month, Year): January, 1991

Till: March, 1991

MDL: 0.2 PPB

Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	12	0.7	0.49	1.9	1.3	0.1	11	
7097-2B	Travis, SI	B	J	10	6.0	3.02	12.9	10.0	2.9	10	
7097-2C	Travis, SI	B	J	14	0.9	0.54	1.9	1.9	0.4	14	
0030-B1	Carteret, NJ	B	J	14	0.6	0.25	1.1	0.9	0.2	14	
0030-B2	Carteret, NJ	B	J	9	0.8	0.24	1.1	1.1	0.4	9	
0030-B3	Carteret, NJ	B	J	14	1.9	1.13	4.4	4.4	0.5	14	

Reduced Data from Canister System

(Quarterly Report)

Agency: NYSDOH

Pollutant: Chloroform

CAS #: 67-66-3

Quarter Beginning (Month, Year): January, 1991

Till: March, 1991

MDL: 0.2 PPB

Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	12	0.4	0.20	0.9	0.7	0.1	11	
7097-2B	Travis, SI	B	J	10	1.2	1.04	4.0	1.8	0.3	10	
7097-2C	Travis, SI	B	J	14	0.1	0.05	0.3	0.1	0.1	1	
0030-B1	Carteret, NJ	B	J	14	0.3	0.15	0.6	0.6	0.1	11	
0030-B2	Carteret, NJ	B	J	9	0.4	0.22	0.9	0.6	0.1	8	
0030-B3	Carteret, NJ	B	J	14	0.1	0.00	0.1	0.1	0.1	0	

Reduced Data from Canister System

(Quarterly Report)

Agency: NYSDOH

Pollutant: Carbon Tetrachloride

CAS #: 56-23-5

Quarter Beginning (Month, Year): January, 1991

Till: March, 1991

MDL: 0.2 PPB

Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	12	0.1	0.00	0.1	0.1	0.1	0	
7097-2B	Travis, SI	B	J	10	0.1	0.00	0.1	0.1	0.1	0	
7097-2C	Travis, SI	B	J	14	0.1	0.00	0.1	0.1	0.1	0	
0030-B1	Carteret, NJ	B	J	14	0.1	0.00	0.1	0.1	0.1	0	
0030-B2	Carteret, NJ	B	J	9	0.1	0.00	0.1	0.1	0.1	0	
0030-B3	Carteret, NJ	B	J	14	0.1	0.00	0.1	0.1	0.1	0	

Reduced Data from Canister System
 Agency: NYSDOH
 Pollutant: Trichloroethylene
 Quarter Beginning (Month, Year): January, 1991
 MDL: 0.2 PPB

(Quarterly Report)
 CAS #: 79-01-6
 Till: March, 1991
 Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	12	0.1	0.00	0.1	0.1	0.1	0	
7097-2B	Travis, SI	B	J	10	0.2	0.14	0.5	0.4	0.1	3	
7097-2C	Travis, SI	B	J	14	0.3	0.35	1.2	0.9	0.1	4	
0030-B1	Carteret, NJ	B	J	14	1.5	1.08	4.3	4.0	0.8	14	
0030-B2	Carteret, NJ	B	J	9	0.2	0.22	0.8	0.4	0.1	3	
0030-B3	Carteret, NJ	B	J	14	0.1	0.05	0.3	0.1	0.1	13	

Reduced Data from Canister System
 Agency: NYSDOH
 Pollutant: 1,1,1-Trichloroethane
 Quarter Beginning (Month, Year): January, 1991
 MDL: 0.2 PPB

(Quarterly Report)
 CAS #: 71-55-6
 Till: March, 1991
 Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	12	0.6	0.40	1.4	1.2	0.2	12	
7097-2B	Travis, SI	B	J	10	0.9	0.50	1.9	1.8	0.4	10	
7097-2C	Travis, SI	B	J	14	0.5	0.42	1.5	1.3	0.1	12	
0030-B1	Carteret, NJ	B	J	14	1.8	0.78	3.5	3.1	0.7	14	
0030-B2	Carteret, NJ	B	J	9	0.9	0.38	1.8	1.8	0.5	9	
0030-B3	Carteret, NJ	B	J	14	3.9	1.85	7.6	6.3	1.9	14	

Reduced Data from Canister System
 Agency: NYSDOH
 Pollutant: Perchloroethylene
 Quarter Beginning (Month, Year): January, 1991
 MDL: 0.2 PPB

(Quarterly Report)
 CAS #: 127-18-4
 Till: March, 1991
 Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	12	0.3	0.33	1.2	0.8	0.1	3	
7097-2B	Travis, SI	B	J	10	0.4	0.55	1.6	1.4	0.1	4	
7097-2C	Travis, SI	B	J	14	0.3	0.41	1.3	1.3	0.1	3	
0030-B1	Carteret, NJ	B	J	14	0.3	0.19	0.7	0.6	0.1	10	
0030-B2	Carteret, NJ	B	J	9	0.4	0.30	1.0	0.6	0.1	5	
0030-B3	Carteret, NJ	B	J	14	0.2	0.19	0.7	0.6	0.1	11	

Reduced Data from Canister System

Agency: NYSDOH

Pollutant: Hexane

Quarter Beginning (Month, Year): January, 1991

MDL: 0.2 PPB

(Quarterly Report)

CAS #: 110-54-3

Till: March, 1991

Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	12	1.5	1.13	4.6	3.1	0.6	12	
7097-2B	Travis, SI	B	J	10	1.4	1.05	4.0	2.9	0.7	10	
7097-2C	Travis, SI	B	J	14	1.0	0.81	2.8	2.7	0.3	14	
0030-B1	Carteret, NJ	B	J	14	0.6	0.55	2.0	1.6	0.1	11	
0030-B2	Carteret, NJ	B	J	9	1.2	1.12	4.3	1.1	0.4	9	
0030-B3	Carteret, NJ	B	J	14	0.9	1.06	3.7	2.5	0.1	9	

Reduced Data from Canister System

Agency: NYSDOH

Pollutant: Benzene

Quarter Beginning (Month, Year): January, 1991

MDL: 0.2 PPB

(Quarterly Report)

CAS #: 71-43-2

Till: March, 1991

Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	12	2.7	1.25	5.6	5.3	1.7	12	
7097-2B	Travis, SI	B	J	10	2.7	1.68	5.9	5.6	1.2	10	
7097-2C	Travis, SI	B	J	14	1.7	1.36	5.0	4.7	0.6	14	
0030-B1	Carteret, NJ	B	J	14	1.5	1.59	6.9	2.3	0.6	14	
0030-B2	Carteret, NJ	B	J	9	1.7	1.41	5.6	1.6	0.9	9	
0030-B3	Carteret, NJ	B	J	14	1.5	1.09	4.1	3.4	0.5	14	

Reduced Data from Canister System

Agency: NYSDOH

Pollutant: Toluene

Quarter Beginning (Month, Year): January, 1991

MDL: 0.2 PPB

(Quarterly Report)

CAS #: 108-88-3

Till: March, 1991

Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	12	15.2	9.97	41.8	22.6	5.5	12	
7097-2B	Travis, SI	B	J	10	12.5	10.17	33.9	28.9	4.5	10	
7097-2C	Travis, SI	B	J	14	4.4	3.73	13.4	12.9	1.4	14	
0030-B1	Carteret, NJ	B	J	14	7.7	3.33	14.7	11.8	3.2	14	
0030-B2	Carteret, NJ	B	J	9	8.0	3.35	15.8	10.8	4.5	9	
0030-B3	Carteret, NJ	B	J	14	5.9	3.01	11.3	10.8	1.7	14	

Reduced Data from Canister System

(Quarterly Report)

Agency: NYSDOH

Pollutant: o-Xylene

CAS #: 95-47-6

Quarter Beginning (Month, Year): January, 1991

Till: March, 1991

MDL: 0.2 PPB

Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	12	1.7	0.73	3.3	3.0	0.8	12	
7097-2B	Travis, SI	B	J	10	8.9	14.75	38.6	38.1	0.9	10	
7097-2C	Travis, SI	B	J	14	1.4	1.38	4.4	4.0	0.2	14	
0030-B1	Carteret, NJ	B	J	14	1.2	0.55	2.3	1.9	0.5	14	
0030-B2	Carteret, NJ	B	J	9	1.7	0.78	3.5	1.9	0.7	9	
0030-B3	Carteret, NJ	B	J	14	1.3	0.78	3.0	2.8	0.4	14	

Reduced Data from Canister System

(Quarterly Report)

Agency: NYSDOH

Pollutant: p-Xylene, m-Xylene

CAS #: 106-42-3, 108-38-3

Quarter Beginning (Month, Year): January, 1991

Till: March, 1991

MDL: 0.4 PPB

Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	12	4.5	1.83	8.4	8.1	2.3	12	
7097-2B	Travis, SI	B	J	10	15.3	22.76	60.7	60.5	1.8	10	
7097-2C	Travis, SI	B	J	14	3.4	3.94	12.8	11.2	0.6	14	
0030-B1	Carteret, NJ	B	J	14	2.9	1.38	5.8	5.1	1.0	14	
0030-B2	Carteret, NJ	B	J	9	4.8	2.41	8.8	8.4	1.9	9	
0030-B3	Carteret, NJ	B	J	14	3.0	1.72	7.0	5.6	1.0	14	

Reduced Data from Canister System

(Quarterly Report)

Agency: NYSDOH

Pollutant: Ethylbenzene

CAS #: 100-41-4

Quarter Beginning (Month, Year): January, 1991

Till: March, 1991

MDL: 0.2 PPB

Units: PPB

Location Code	Site	Sampling Code	Analytical Code	# of Samples	Arith Mean	Std. Dev.	1st Max	2nd Max	Min	# > MDL	FC
7097-2A	Travis, SI	B	J	12	1.1	0.56	2.3	2.3	0.5	12	
7097-2B	Travis, SI	B	J	10	6.0	9.45	25.1	24.7	0.5	10	
7097-2C	Travis, SI	B	J	14	1.0	1.12	3.5	3.0	0.1	12	
0030-B1	Carteret, NJ	B	J	14	0.8	0.48	2.0	1.7	0.3	14	
0030-B2	Carteret, NJ	B	J	9	1.2	0.54	2.3	1.7	0.5	9	
0030-B3	Carteret, NJ	B	J	14	0.8	0.53	2.0	1.8	0.2	14	

Reduced Radon Data

Quarterly Report

Sampling Agency: NYSDOH
 Pollutant: Radon
 Analytical Laboratory: EPA Las Vegas
 MDL: 0.19 pCi/l*

CAS #:
 Units: pCi/l

Quarter Beginning (Month, Year): July 1990

Ending: September 1990

Location Code	Site	# of valid samples	Arith mean	Std. dev.	1st Max	2nd Max	Min	# > MDL
12	Carteret	3	0.70	0.03	0.73	0.71	0.67	3
15	Carteret	3	0.59	0.04	0.63	0.58	0.55	3
25	Carteret	3	0.40	0.06	0.47	0.36	0.36	3
26	Carteret	3	0.49	0.21	0.73	0.43	0.32	3
37	Carteret	1	0.30	-	-	-	-	1
41	Travis	2	0.33	0.04	0.35	-	0.30	2
43	Travis	2	1.12	1.04	1.86	-	0.39	2
53	Travis	3	0.34	0.09	0.44	0.29	0.28	3
54	Travis	3	0.49	0.20	0.72	0.39	0.35	3
67	Travis	2	0.92	0.64	1.37	-	0.42	2

Quarter Beginning (Month, Year): October 1990

Ending: December 1990

Location Code	Site	# of valid samples	Arith mean	Std. dev.	1st Max	2nd Max	Min	# > MDL
12	Carteret	5	0.76	0.07	0.85	0.79	0.73	5
15	Carteret	5	0.60	0.12	0.75	0.66	0.46	5
25	Carteret	6	0.44	0.12	0.60	0.53	0.30	6
26	Carteret	6	0.44	0.14	0.59	0.52	0.19	6
41	Travis	5	0.44	0.17	0.71	0.43	0.25	5
43	Travis	6	0.45	0.03	0.49	0.48	0.41	6
53	Travis	6	0.60	0.23	0.93	0.77	0.33	6
54	Travis	6	0.48	0.07	0.60	0.53	0.38	6

Quarter Beginning (Month, Year): January 1991

Ending: March 1991

Location Code	Site	# of valid samples	Arith mean	Std. dev.	1st Max	2nd Max	Min	# > MDL
12	Carteret	3	0.78	0.05	0.82	0.79	0.72	3
15	Carteret	3	0.61	0.12	0.75	0.55	0.52	3
25	Carteret	3	0.36	0.06	0.43	0.34	0.31	3
26	Carteret	3	0.33	0.11	0.46	0.28	0.25	3
41	Travis	2	0.33	0.06	0.37	-	0.29	2
43	Travis	2	0.90	0.66	1.36	-	0.43	2
53	Travis	3	0.51	0.05	0.56	0.49	0.47	3
54	Travis	3	0.54	0.18	0.74	0.47	0.40	3

*Not corrected for background outdoor sample concentration. 0.19 pCi/l is the minimum detectible amount (MDA) in the report, "National Ambient Radon Study" (1991 report). The MDA for that study was defined as 1.645 standard deviations above the limit of detection (LOD); and the LOD, 0.054 pCi/l, was defined as three standard deviations above the average measurement on a field blank.

Key to location codes:

12	Carteret 0030-B1, 1st flr. rec. room	41	Travis 7097-2A, 1st flr. playroom
15	Carteret 0030-B1, 2nd flr. kitchen	43	Travis 7097-2A, 1st flr. living room
25	Carteret 0030-B2, 2nd flr. kitchen	53	Travis 7097-2B, 1st flr. living room
26	Carteret 0030-B2, 2nd flr. bathroom	54	Travis 7097-2B, 1st flr. kitchen
37	Carteret 0030-B3, outdoors on school roof	67	Travis 7097-2C, outdoors on school roof

Appendices

APPENDIX A

STATEN ISLAND/NEW JERSEY URBAN AIR TOXICS ASSESSMENT PROJECT

INDOOR AIR WORKPLAN

I. Background

The New Jersey/Staten Island area represents a highly industrialized and urbanized section of the United States. Many petrochemical industry facilities are located along the Arthur Kill. To address public concern about air quality and adverse health risks, the SI/NJ UATAP project is being conducted. The overall purpose of the project is to characterize the concentrations of several organic and inorganic compounds found in the ambient air and to evaluate the relative risk from inhalation exposure to these compounds. Ambient air sampling has been conducted at several sites in New York and New Jersey since 1988 to characterize exposure to air contaminants in this area.

Many hours of a person's day are spent inside the home. The ambient air is often the most important source of contaminants in indoor air. However, indoor sources can predominate in some circumstances. The indoor air portion of the SI/NJ UATAP project is designed to provide information on the relative importance of indoor air contaminant sources. Indoor air contaminant levels will be determined in four homes, concurrently with sampling of contaminant levels at nearby ambient monitoring stations. Tentative sampling locations are residences close to PS 26 in Travis on Staten Island and close to the police station in Carteret, New Jersey, and at the ambient monitoring sites in those locations. The residences will be selected as not atypical in terms of construction and observable sources of indoor air contaminants. Because there will be only a small number of sample locations, the data collected will not be representative in the sense of permitting extrapolation to the entire study area. Data obtained from this investigation will aid in characterizing the relative risks of indoor and outdoor exposure for those homes tested in the New Jersey/Staten Island area.

II. Purpose

Determine how nearly indoor air contaminant levels in houses near two of the project ambient air monitoring sites correspond to ambient levels at the monitoring stations. If there is a significant difference between indoor and ambient levels at either site, characterize the difference in terms of exposure for hypothetical residents of these houses.

III. Objective A

Select homes to be used in this study.

Task A.1 NYSDOH will canvas the areas door-to-door to seek volunteer homeowners. At least two homes in Staten Island and two homes in New Jersey will be identified for sampling.

Task A.2 Criteria for selection will be based on the following:

- a) Criteria for ideal sampling location:
 - (i) residence is located within 1/2 mile of an outdoor air monitoring station presently used in this study.
 - (ii) At least half of the organic chemicals of interest (See Objective C) have been regularly detected at the outdoor air monitoring station.
 - (iii) residence has had no major heating oil spill occurrence and all minor leaks to oil storage tank have been repaired.
 - (iv) residence should not contain woodstove, kerosene space heater, or kerosene lamps.
 - (v) residence does not contain large amounts of paints, solvents, adhesives, etc. that may contribute to concentrations of the specified organic compounds.
 - (vi) residence should not be a mobile home.
 - (vii) residence should not contain urea-formaldehyde foam insulation.
 - (viii) residence is not located within 1/8th mile of a gasoline station, oil storage facility, propane storage and/or dispenser facility, dry cleaning business or any other business known to emit any of the organic chemicals selected for analysis in this project.
 - (ix) residence should be greater than 1/8th mile from a large parking facility, bus garage, airport or train station.
 - (x) occupants of residence do not smoke.
 - (xi) residence has a detached garage or no garage structure.

- (xii) residence has not been remodeled in previous 12 months.
 - (xiii) residence should not have pressed wood furniture, upholstered furniture, carpeting or draperies purchased in the last 12 months.
 - (xiv) draperies and furniture coverings in the residence should not have been dry cleaned within the past six months; carpets should not have been professionally cleaned within past six months.
- b) If a location cannot be found to meet all of the above criteria, the following criteria will apply:
- (i) criteria i-vii must be met.
 - (ii) residents must agree not to smoke indoors 12 hours prior to sampling and during sampling.
 - (iii) in a residence with an attached garage, the garage should not be used to store chemicals, oil or gasoline.
 - (iv) if residence has been recently remodelled or new furniture, carpeting or draperies have been added in the past 12 months, the sample should be taken in a room away from the new installations/furnishings.
 - (v) If any draperies or furniture coverings have been dry cleaned or carpets commercially cleaned in the past 6 months, the sample should be taken in rooms where this had not been done.

IV. Objective B

Collect indoor air samples in selected homes.

- Task B.1 Prepare and distribute brief factsheet on the project and permission forms for homeowners. Obtain written permission from homeowner and provide to homeowner a list of conditions for sampling which they must agree to for the duration of the study.
- Task B.2 Complete "Indoor Air Quality Residential Questionnaire" for each home. Complete "Daily Activity/Product Use Questionnaire" each day the home is sampled.
- Task B.3 Place evacuated canisters in homes (first floor living space) with flow controller and timer set for a 12 hour sampling interval. Two consecutive 12-hour samples will be collected at a pre-determined hour every 12

days for eight months. Start and stop times will coincide with the outdoor air monitoring. Filled canisters will be transported to the New York State Department of Health Wadsworth Center for Laboratories and Research for analysis.

Task B.4 Conduct formaldehyde sampling simultaneously with canister sampling. Cartridges for formaldehyde will be obtained from and analyzed by EPA contract laboratory.

V. Objective C

Collect ambient air samples and meteorological data concurrently with indoor air samples.

TASK C.1 Conduct ambient air sampling utilizing the same methods (tasks B.3 and B.4) every 12 days at two ambient monitoring stations for eight months. This represents 18 days of sampling, each day composed of two 12-hour samples at two ambient air monitoring stations.

Task C.2 Install recording meteorological instruments at each ambient air monitoring station. Collect meteorological data for an eight month sampling period.

VI. Objective D

Analyses - See attached methodology. [in project files]

Task D.1 Canisters: Analyze indoor and ambient air samples for the specified twelve volatile organic compounds. These compounds are:

chloromethane	tetrachloroethylene
methylene chloride	benzene
chloroform	toluene
1,1,1-trichloroethane	hexane
carbon tetrachloride	o-xylene, m,p-xylenes
trichloroethylene	ethylbenzene

Task D.2 Cartridges: Analyze cartridges for formaldehyde. Cartridges will be obtained from and analyzed by EPA consultant. Collection and analysis procedures obtained from EPA.

VII. Objective E

Implement a quality control procedure to insure comparability and quality of the monitoring data.

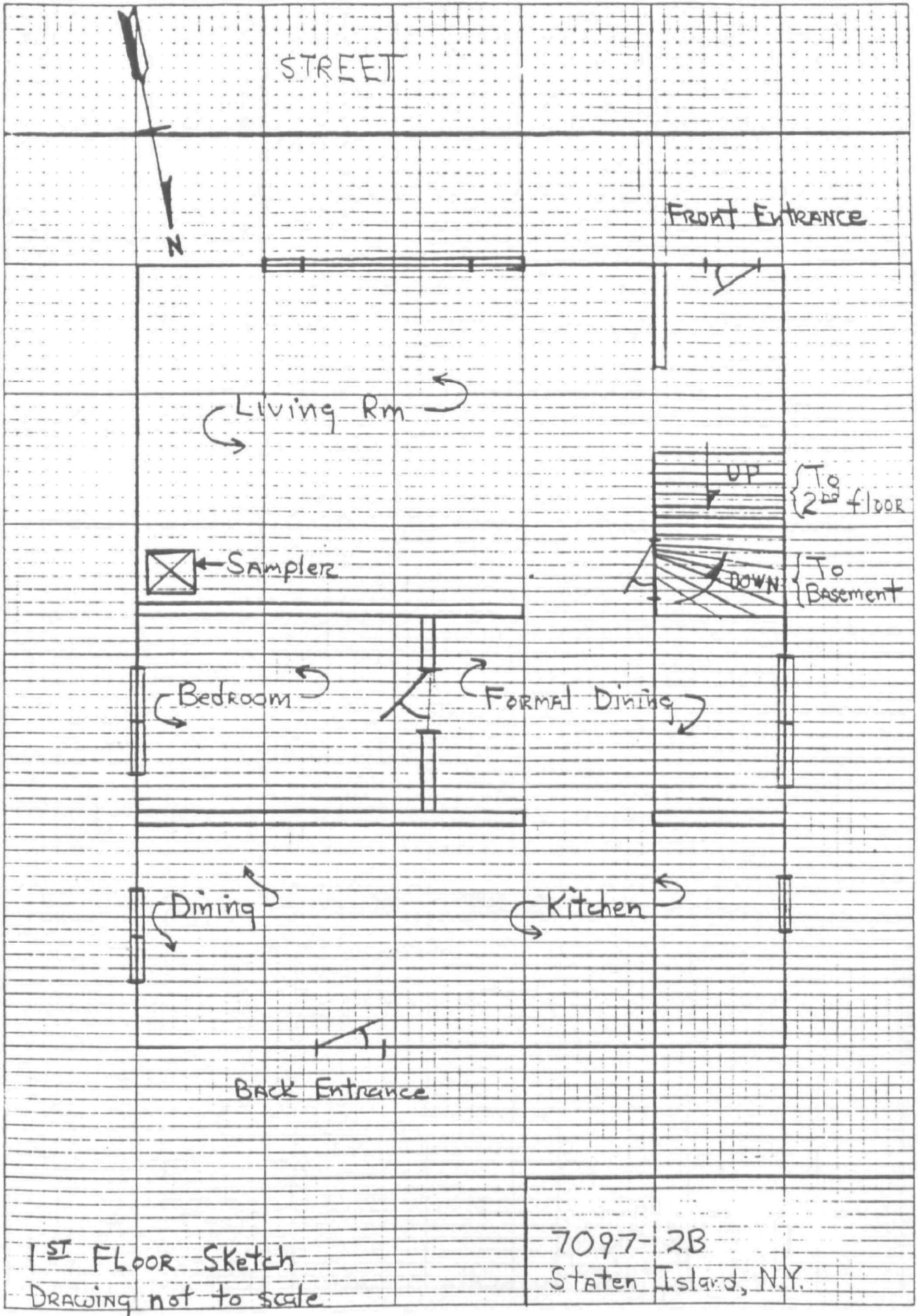
- Task E.1 Wadsworth Center for Laboratories and Research will undergo a "Shoot Out" with EPA's Edison Laboratory.
- Task E.2 One canister will be treated as a field blank for every ten sample canisters, as the standard quality control practice. The house where the canister will be "exposed" will be changed on different sampling occasions.
- Task E.3 On every third sampling day (36 calendar days) duplicate canisters will be collected and sent to EPA's Contract Laboratory for analysis.

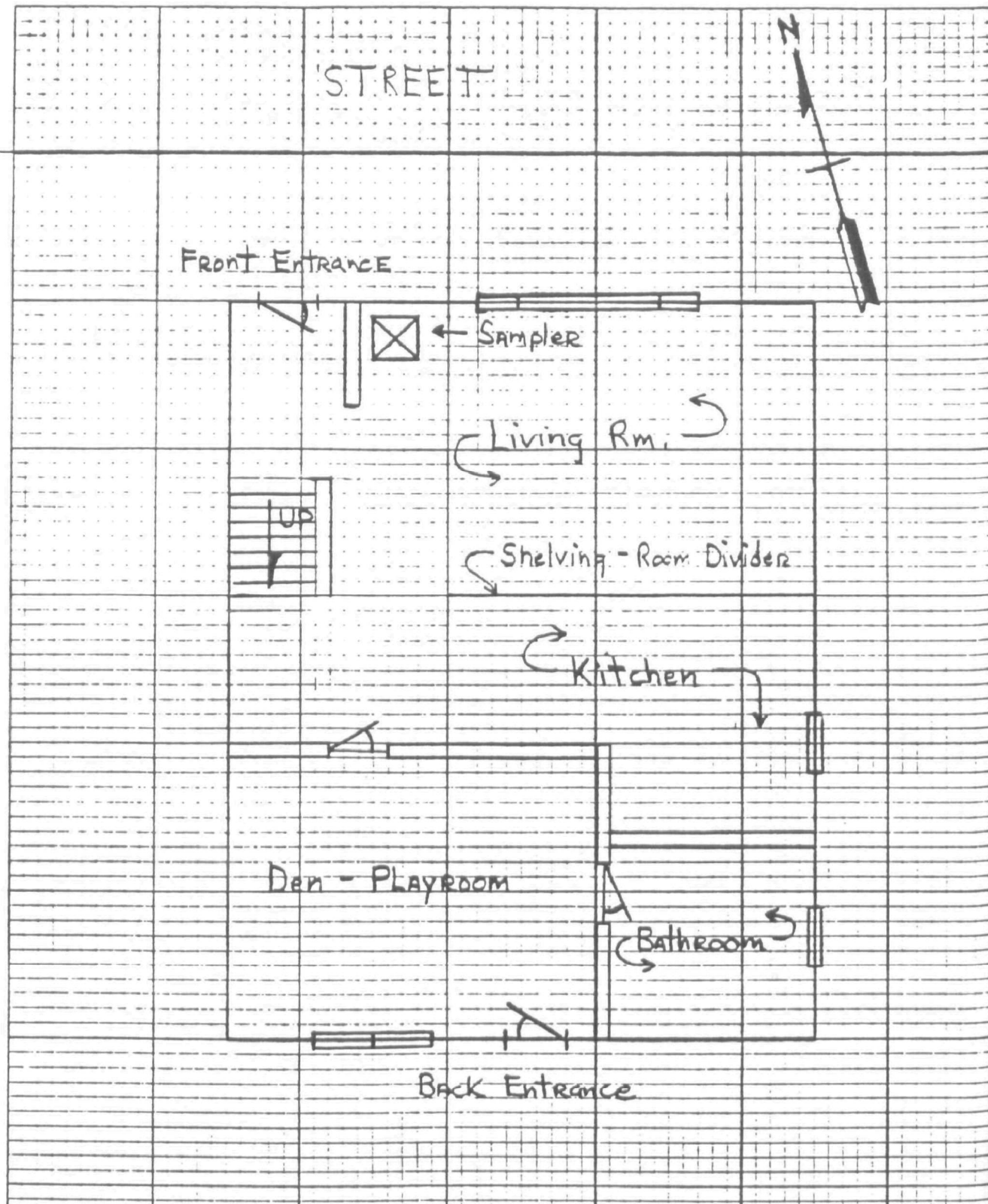
VIII. Objective F

Prepare report summarizing data and drawing conclusions regarding indoor/outdoor contaminant levels.

- Task F.1 Every three months, a status report will be issued by the Indoor Air Sub-group based on data collected over the previous quarter. Report will be distributed within 45 days of end of quarter. Status report will include a summary of analytical data regarding indoor and outdoor contaminant levels.
- Task F.2 Within 45 days of the last sampling event, a final report will be prepared and distributed by the Indoor Air Sub-group that will present the data compiled over the period of the study and provide conclusions regarding that data.

APPENDIX B : Floor Plans



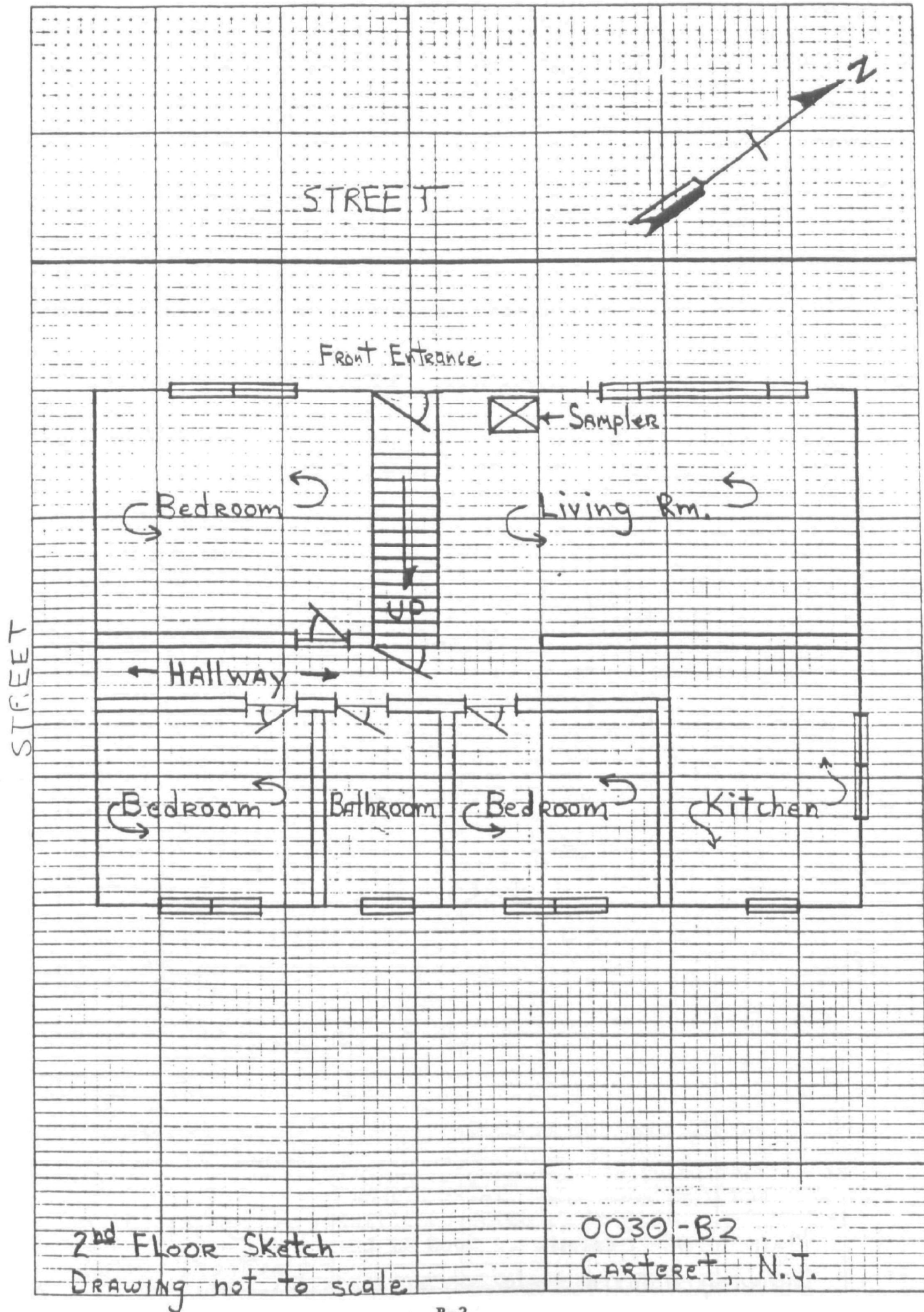


1ST FLOOR Sketch

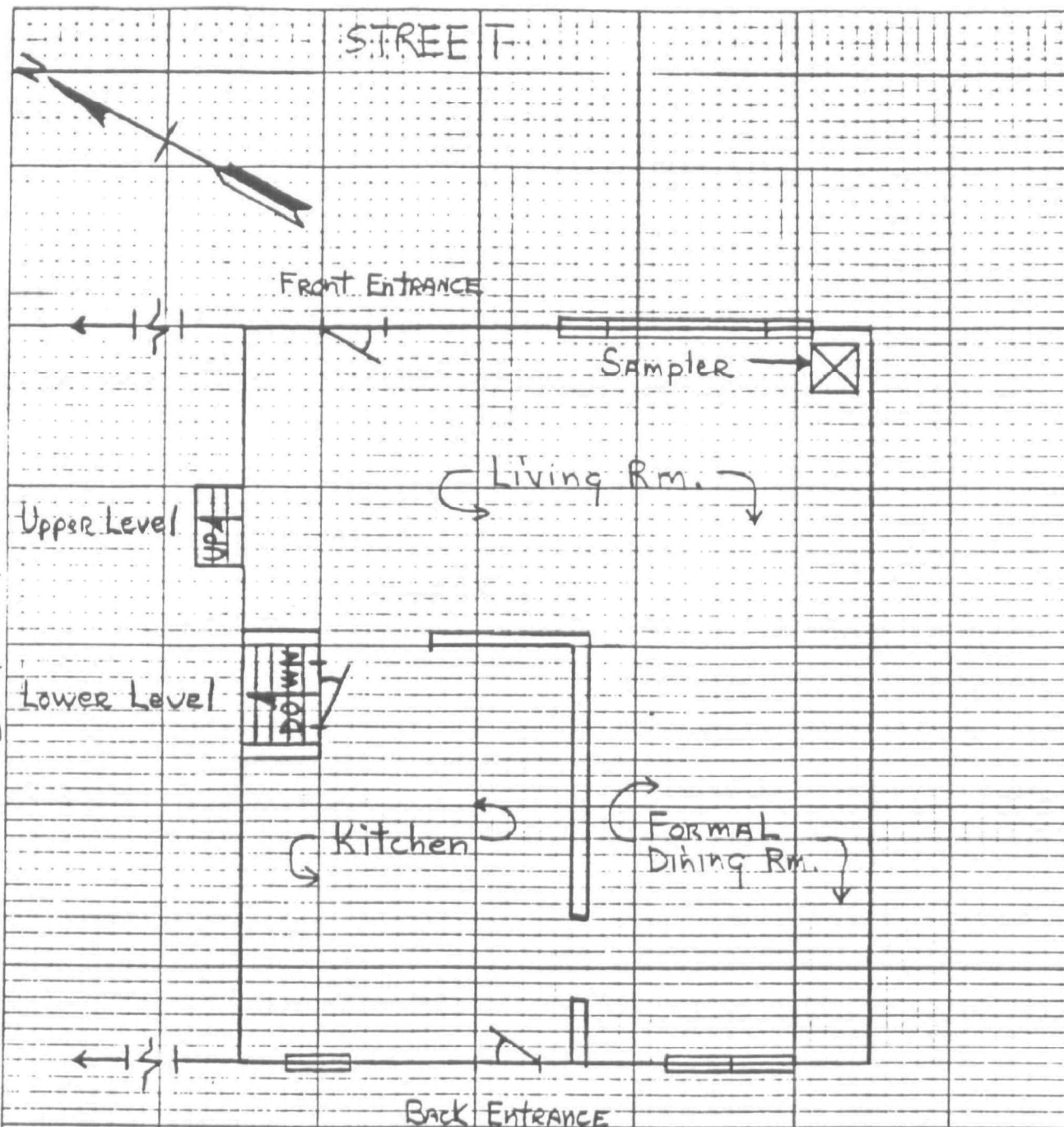
Drawing not to scale

7097-2A

Staten Island, NY



STREET



Main Level Sketch
Drawing not to scale

0030-B1
Carteret, N.J.

Standard Operating Procedure for Determining Flow Rates in the Three Channels of the Indoor Air Project Formaldehyde Samplers

1. Take three formaldehyde sample tubes to the sampling location. These are for the 1st 12 hour, 2nd 12 hour, and 24 hour samples.
2. Choose a tube for the 1st 12 hour sample and record the tube # on the sampling sheet.
3. Install tube on the appropriate channel as indicated by the color coded guide located on the inside cover of the sampler.
4. Repeat steps 2 and 3, for the 2nd 12 hour and 24 hour samples.
5. Attach rotameter and tubing to the 24 hour channel.
6. Set up 12 hour channel so that the first 12 hour sample is activated. (With the unit facing front, the clock controlling the 12 hour channel is on the left hand side. Activating the first 12 hour sample is achieved by manipulating the on/off knob of the timer so that the bottom tooth of the trigger is perpendicular to the clock wheel.)
7. Measure and record the flow rate on the sample sheet in the 24 hour tube/1st 12 hour period box.
8. Switch the 12 hour channel so that the second 12 hour sample is activated. This is done by turning the timer on the 12 hour channel clock (the clock on the left hand side) until the timing trigger is set off by the red lug on the clock.
9. Record the flow rate observed with the rotameter on the sampling sheet in the 24 hour/2nd 12 hour sample box.
10. Disconnect the rotameter from the 24 hour channel and attach it to the twelve hour channel.
11. Record the flow rate on the sample sheet in the 2nd 12 hour sample/2nd 12 hour period box.
12. Switch the 12 hour channel so that the first 12 hour sample is being taken. Follow the steps for this procedure as indicated in step #6.
13. Record the flow rate on the sample sheet in the 1st 12 hour sample/1st 12 hour sample period box.
14. Disconnect the rotameter.
15. Make sure that the 12 hour channel is set so that the first twelve hour sample tube is activated. This is done by examining the bottom tooth of the timing trigger and verifying that it is perpendicular to the the timing wheel. Make sure that the timer is set for 12 so that a full revolution of the clock (12 hours) will pass before the second 12 hour sample is taken.
16. Make sure that the timer on the right of the unit is on.

Formaldehyde Sample Information Sheet

Date: _____ Time: _____

Location: _____

Pre Sampling Flow Measurements (L/Min)

	Tube #	1st 12 hour sampling period	2nd 12 hour sampling period
1st 12 hour tube			-----N/A-----
2nd 12 hour tube		-----N/A-----	
24 hour tube			

Timer Readings

	Prior to sampling	After sampling
7 day timer reading:		
24 hour channel timer readings: (located on the right)		
12 hour channel timer readings: (located on the left)		

Post Sampling Flow Measurements (L/Min)

	Tube #	1st 12 hour sampling period	2nd 12 hour sampling period
1st 12 hour tube	As Above		-----N/A-----
2nd 12 hour tube	As Above	-----N/A-----	
24 hour tube	As Above		

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DNPH-Coated Silica Cartridges for Sampling Carbonyl Compounds in Air and Analysis by High Performance Liquid Chromatography

by

Silvestre B. Tejada

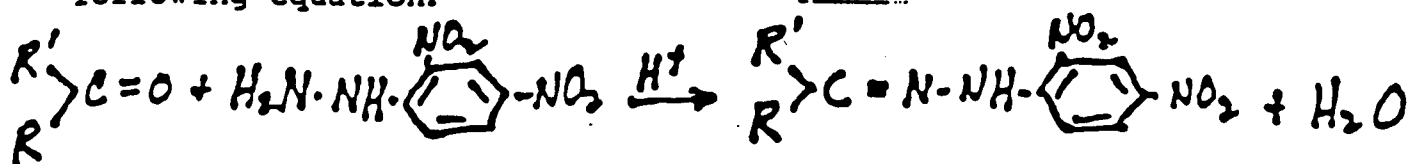
Mobile Source Emissions Research Branch
Atmospheric Sciences Research Laboratory
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

INTRODUCTION

This report describes procedural details for coating silica in pre-packed plastic cartridges with 2,4-dinitrophenylhydrazine (DNPH) and for sampling carbonyl compounds in air with these devices. Experimental results of the comparison of the cartridge and the DNPH/ACN impinger techniques for sampling carbonyl compounds in dilute automotive exhaust emissions and in ambient air are presented.

Qualitative and quantitative data show that the cartridge and the DNPH/ACN impinger sampling methods are equivalent. The data also support the tentative identification of an unknown degradation product of acrolein-DNPH derivative.

The method is based on the specific reaction of organic carbonyl compounds (aldehydes and ketones) with DNPH in the presence of an acid to form stable derivatives according to the following equation:



R and R' can be any organic radical or hydrogen.

Carbonyl compounds in ambient air or in diluted automotive exhaust are collected by passing the sample through a pre-packed cartridge (Waters Associates Sep-PAK) containing chromatographic grade silica gel that has been coated in situ with acidified DNPH. The DNPH derivatives are analyzed by high performance liquid chromatography (HPLC) using spectrophotometric detection

at 360 nm. DNPH-coated cartridges are not commercially available at present.

The method as described here is applicable to a variety of sampling situations and can be applied to the determination of carbonyl compounds in automotive emissions as well as in residential indoor and ambient outdoor atmospheres.

Aldehydes and ketones as DNPH derivatives can be detected at 0.5 ng level (S/N >2) on column (25-uL sample injection) with our present instrumentation and chromatographic conditions (see Figure 1). Past experiences with standard synthetic mixtures have shown that a relative standard deviation (RSD) of about 10% in peak area measurements can be achieved, under favorable conditions, when the concentration of the DNPH derivative in solution is about 0.1 ug/mL (equivalent to 2.5 ng on column). At 0.2 ug/mL and at 0.4 ug/mL and higher, RSD of about 5% and 3%, respectively, can be achieved. With peak height quantitation, under similar conditions, RSD of about 10% can be achieved at 0.025 ug/mL and about 5% at 0.05 ug/mL. At 0.1 ug/mL and higher, RSD of about 2% can be achieved. Retention times of synthetic standards have been reproduced to about 1% RSD for a multiple injections of a solution of mix standards that spanned over two months.

EXPERIMENTAL

Instrumentation: A gradient HPLC (Varian Model 5000) system equipped with a UV(360 nm) detector (ISCO Model 1840 variable wavelength detector), an automatic sampler with a 25-uL loop injector and two DuPont Zorbax ODS columns (4.6-mm by 25-cm), a recorder and an electronic integrator.

Apparatus and Equipments:

1. Hot plates, beakers, flasks, measuring and disposable pipets, volumetric flasks, etc.
2. Impingers
3. Rotameters, metal bellows or diaphragm pumps
4. Calibrated syringes as required
5. Special glass apparatus for rinsing, storage and dispensing of saturated DNPH stock reagent (Figure 2).

6. Mass flow meter and mass flow controllers
7. Melting point apparatus
8. Positive displacement, repetitive dispensing pipets (Lab-Industries or equivalent), 0 to 10 mL range.
9. Three-way solenoid valves
10. Programmable timers
11. Cartridge drying manifold with multiple standard male Luer connectors (at least 6). The manifold is connected to a cylinder of nitrogen.
12. Liquid syringes, 10 mL (Polypropylene syringes are adequate).
13. Syringe rack. The unit is made of an aluminum plate (1/16 x 14 x 21 in.) with adjustable legs on four corners. A matrix (5 x 9) of circular holes with diameter slightly larger than the diameter of the 10-mL syringes were symmetrically drilled from the center of the plate. This permits batch processing of 45 cartridges for cleaning, coating and/or sample elution.
14. Teflon FEP tubing (1/4" O.D. x 1" long). Both ends of the tubing were flared using a heated glass rod. This tubing is used for coupling cartridges.
15. Cartridge sampling manifold. This is all glass construction and consists of 4 cartridge ports and a male ball joint for connection to existing aldehyde dilution tunnel sampling probe. Short pieces of Teflon FEP tubing (1/4" O.D. x 1.5" long) were heat shrunk around the outside diameter and about 3/4" deep of the cartridge ports. The free ends of the FEP tubing were flared as in 13. The manifold is wrapped with silicone rubber insulated heating tape.
16. Ambient air sampling probe. This is all glass construction with ball joint fitting for connection to the cartridge sampling manifold or to an impinger. The unit is coated with an "Instatherm" heating element and is equipped with an all glass check valve. This unit was originally designed to minimize possible interference of ACN vapors diffusing from the impingers via the sampling probe during simultaneous collection of hydrocarbon and aldehyde samples. Cartridge sampling does not require the air sampling probe when the temperature is a few degrees above freezing. The heated probe is absolutely necessary when the temperature approaches 0°C.

Reagents:

1. 2,4-Dinitrophenylhydrazine - Aldrich Chemical or J.T. Baker, reagent grade or equivalent.

2. Acetonitrile - UV grade, -Burdick and Jackson "distilled-in-glass" or equivalent.
3. Water - charcoal filtered deionized water
4. Perchloric acid - analytical grade, best source
5. Hydrochloric acid - analytical grade, best source
6. Aldehydes and ketones for preparation of DNPH derivative standards - best available grade
7. Carbonyl standards - as 2,4-DNPH derivatives prepared as described later.
8. Ethanol or methanol - best source
9. Sep-PAX silica gel cartridge (Waters Associates, Milford, Massachusetts)

Purification of 2,4-DNPH Reagent: Prepare a supersaturated solution of DNPH by boiling excess DNPH in 200 mL of ACN. Transfer the supernatant to a beaker, put a cover glass and allow to cool gradually to 40-60°C by putting the beaker on a hot plate. This maximizes crystal size and purity. Allow 95% of the solvent to evaporate slowly at this temperature range. Additional supersaturated solution maybe added if more materials are needed. Decant the last remaining saturated solution to waste and rinse the crystals twice with about three times their apparent volume with ACN. Transfer the crystals to another clean beaker, add 200 mL of ACN, heat to boiling, and again allow the crystals to grow slowly at 40-60°C until 95% of the solvent has evaporated. Repeat the rinsing process. Take an aliquot of the second rinse, dilute 10 times with ACN, acidify (1 mL of 3.8M perchloric acid per 100 mL of DNPH solution), and analyze by HPLC. The impurity level should be comparable to that shown in Figure 1. Repeat the crystallization process if the impurity level is unsatisfactory.

Trace impurities can be conveniently removed after the second recrystallization by using the special apparatus shown in Figure 2. Transfer the crystals to the apparatus, add 20 mL of ACN, agitate gently, allow to equilibrate for 10 minutes and drain the solution by properly positioning the three-way stopcock. Check that the special stopper with the DNPH-coated silica cartridge is used during liquid transfer. The purified crystals should not be allowed to contact laboratory air except for a brief moment when additional solvent is being added to the crystal reservoir. After draining turn the stopcock so that the drain tube is connected to the side or measuring reservoir. Immediately rinse the stopcock and drain tube. Introduce the ACN through the measuring reservoir. The rinse solution from the purified crystal reservoir should be checked for impurity level

by HPLC as previously described. Rinsings should be repeated with 20 mL portions of ACN until satisfactory impurity level is attained. The large crystals obtained in the purification process not only enhance the removal of surface impurities but also minimize material loss during rinsing (due to decreased solubility rate of the crystals) as a direct consequence of significant decrease in specific surface area of the crystals.

Preparation of Stock DNPH Reagent: Once the crystals have been satisfactorily cleaned in the special glass apparatus, add about 40 mL of ACN to the crystal reservoir. Agitate the mixture gently and allow to equilibrate overnight. The saturated solution above the large excess of purified crystals is used as stock reagent in the preparation of the absorbing solution. The stock solution contains about 11 mg DNPH per mL at room temperature.

If the special glass apparatus is not available, transfer the purified crystals to an all glass reagent bottle, add about 200 mL ACN, stopper, shake gently and allow to stand overnight. Use "clean" pipets and rubber bulbs when taking aliquots of the saturated solution. Do not pour from the reagent bottle.

The use of the special glass apparatus minimizes contamination from laboratory air.

Preparation of Carbonyl-DNPH Derivative: Titrate a saturated solution of DNPH in 2N HCl with the individual aldehyde or ketone. Filter the colored precipitate, wash with 2N HCl and water and allow to air dry. Check the purity of the derivative by melting point determination. Recrystallize from absolute ethanol or methanol if necessary. Check chromatographic purity by HPLC analysis of a dilute solution of the derivative in ACN.

Standards: Prepare standard stock solutions of the individual DNPH derivatives by dissolving accurately weighed amounts in ACN. Prepare a working calibration standard mix from the individual standard stock solutions. If possible, the concentrations of the individual carbonyl compounds in the standard mix should be adjusted to reflect their relative distribution in real samples. It is sometimes desirable to dissolve a small piece of DNPH single crystal in the standard mix to provide a reference peak in calibration chromatograms. Store all standard solutions in the refrigerator. They should be stable for several months.

Standard solutions of the aldehydes can also be prepared in ACN and mixed with acidified DNPH as needed. We feel this is a less convenient method than the method described in the previous paragraph especially for daily routine analysis of a large number of samples and where an automated sampler is available.

Preparation of DNPH-Coated Sep-PAK Cartridge

This procedure must be performed in a very low aldehyde background atmosphere. All glasswares and plasticwares must be

scrupulously cleaned and rinsed with deionized water and aldehyde-free ACN. Contact of reagents with laboratory air must be minimized. Wear polyethylene gloves when handling the cartridges.

DNPH Coating Solution: Dilute 25 mL of saturated DNPH stock solution to 1000 mL with ACN in a reagent bottle equipped with a positive displacement repetitive dispenser. Acidify with 1.0 mL of concentrated HCl. The atmosphere above the acidified solution should preferably be filtered through DNPH-coated silica cartridge to minimize contamination from laboratory air. Prime the dispenser and slowly dispense 10 to 20 mL to waste. Dispense an aliquot to a sample vial and check the impurity level of the acidified solution by HPLC analysis using gradient program similar to those given in Optimization of Chromatographic Conditions section. The impurity level should be similar to that shown in Figure 1.

Coating Procedure: Open the Sep-PAK packet and connect the short end of the cartridge to a 10-mL syringe and place in the syringe rack. Prepare as many cartridges and syringes as the syringe rack can hold. For lot consistency, it is important that a large batch is coated in assembly line fashion. Using a positive displacement repetitive pipet, add 10 mL of ACN to each of the syringes and allow the liquid to drain by gravity to a waste reservoir. Remove any air bubbles which may be trapped between the syringe and the silica cartridge by displacing it with ACN in the syringe. A long tipped disposable Pasteur pipet equipped with a medicine dropper rubber bulb is convenient for this purpose.

Set the repetitive dispenser containing the acidified DNPH coating solution to dispense 7 mL. Once the ACN rinse solution is completely drained into the cartridge and the effluent flow at the outlet of the cartridge has stopped, dispense 7 mL of the coating reagent into each of the syringes. Air is usually trapped between the cartridge and syringe and should be displaced with the coating reagent in the same manner mentioned above. Allow the coating reagent to drain by gravity until flow at the other end of the cartridge stops. Wick the excess liquid at the outlet of each of the cartridges with clean tissue paper. The cartridges should be coated with about 1.9 mg of acidified DNPH.

Remove a batch of cartridges from the syringes and connect the short ends of the cartridges to the Luer ports of the drying manifold. Pass nitrogen through each of the cartridges at about 300-400 mL/min for 15 minutes. Within 10 minutes of the drying process, rinse the exterior surfaces and outlet ends of the cartridges with ACN using a Pasteur pipet. After 15 minutes, stop the nitrogen flow and connect clean Teflon FEP cartridge connectors to the long end of the dry cartridges. This first batch of cartridges will serve as scrubbers for any carbonyl present in nitrogen and can be reused for subsequent cartridge drying operation.

With the scrubbers in place, connect the short ends of the

next batch of cartridges to be dried and pass nitrogen at about 300-400 mL/min for 15 minutes. Rinse the exterior surfaces and outlets of the cartridges as described above. After drying, put the cartridges in an all glass stoppered reagent bottle and store in the refrigerator. Randomly select 2-3 cartridges from the lot and determine background impurity levels according to procedures detailed in the Analysis section.

(Note: It is recommended to plug both ends of the coated cartridge before storing. Plastic male Luer plugs are ideal for this purpose and are available commercially).

Sampling:

1. Dilute Exhaust Emissions: The sampling train using the cartridges is shown schematically in Figure 3. The coated cartridges should be allowed to warm to room temperature in a capped reagent bottle prior to connection to the sampling train. The cartridge should be connected to the sampling train so that its short end becomes the sample inlet. Maximum flow obtained with a single DNPH-coated sep-PAK cartridge is about 1.7 L/min and about 0.8 L/min with two cartridges in series. Sampling rate for the cartridges should be about 200 mL/min to give comparable sensitivity with our standard impinger technique (25 mL final absorbing solution volume, sampling rate at 1 L/min). Higher sampling rate should be used if higher analytical sensitivity is desired.

Impinger samples are collected at nominal flow rate of 1 L/min using one impinger containing 20 mL of acidified DNPH solution. The DNPH absorbing solution is prepared by diluting 10 mL of the saturated DNPH stock solution to 100 mL with ACN and adding 1.0 mL of 3.8 M perchloric acid.

Individual mass flow controller for each cartridge sampler in conjunction with a calibrated mass flow meter is recommended especially at low sample flow and short sampling time. The mass flow meter and mass flow controllers should be periodically checked against a soap bubble flow meter.

2. Ambient Air: The pumping system for ambient air sampling is similar to that used in diluted exhaust emissions sampling. The sensing units and associated electronics of the mass flow meter and mass flow controllers should be housed in an environmental chamber. The coated cartridges can be used as direct probes and traps for sampling ambient air when the temperature is above freezing. A heated probe and manifold similar to those described in the Apparatus and Equipment Section is recommended when sampling ambient air near or below 0 °C. The rationale for this is discussed in the Results and Discussion Section.

Typical flow rate through one cartridge is about 1.5 L/min

and about 0.8 L/min for two cartridges in series. Impinger samples are collected, depending on sampling duration, at 0.5-2.0 L/min through the heated glass probe equipped with a check valve. Generally, two impingers in series, each containing 20 mL of acidified DNPH solution are used when sampling for longer than an hour or at flow rates greater than 1 L/min.

When parallel impinger and cartridge samples are collected, the outputs of each of the sampling pumps are sequentially directed to a calibrated mass flow meter for 7 minutes followed by no-flow condition through the mass flow meter for 3 min. The no-flow condition establishes detector zero. The mass flow meter output is continuously monitored with an analogue recorder. The recorder trace provides a record of the performance of major components of the sampling system.

Optimization of Chromatographic Conditions: Chromatographic condition was optimize to separate acrolein, acetone and propionaldehyde and the higher molecular weight aldehydes and ketones within an analysis time constraint of about one hour. With two Zorbax ODS columns in series and at one mL per minute flow, the following gradient program was found adequate: On sample injection, linear gradient from 60% to 75% ACN in 30 minutes, linear gradient from 75% to 100% ACN in 20 minutes, hold at 100% ACN for 5 minutes, reverse gradient to 60% in 1 minute and isocratic at 60% for 15 minutes. Figure 5, shows the separation of a 15 standard calibration mix using this program. This gradient program is a recent modification to effect better resolution of the C-3, C-4 and benzaldehyde regions. With this modification, the degradation product of acrolein DNPH derivative is cleanly resolved from the propionaldehyde derivative peak. What appeared to be a single benzaldehyde derivative peak in a sample of diesel exhaust with our previous elution program (see Figure 4 caption) was found to be actually two peaks with benzaldehyde being the minor component.

(Note: The chromatographic conditions described here has been optimized for our particular laboratory instrumentation. Analysts are advised to experiment with their HPLC systems to optimized chromatographic conditions for their particular analytical needs. Highest chromatographic resolution and sensitivity are desirable but may not be achieved. The separation of acrolein, acetone and propionaldehyde should be a minimum goal of the optimization.)

Analysis: Connect the sample or blank cartridge (outlet end during sampling) to a clean syringe, dispense about 6 mL ACN and place the syringe in the syringe rack to drain. Collect the eluate in a graduated test tube or 5 mL volumetric flask. Fill up

(Note: A dry cartridge has an ACN hold up

volume slightly greater than 1 mL. The eluate flow may stop before the ACN in the syringe is completely drained into the cartridge. This is usually due to air trapped between the cartridge filter and the syringe Luer tip. If this happens, displace the trapped air with the ACN in the syringe using a long tip disposable Pasteur pipet.)

to the 5-mL mark with ACN. Pipet aliquots into sample vials and load on the tray of automatic sampler. Fill two sample vials with standard calibration mix and place at the start and end of the sample series. Alternatively samples may be injected manually. Cartridge samples should not be eluted if they cannot be analyzed within 24 hours. They should be stored, preferably plugged at both ends, in capped all polypropylene or all glass reagent bottle in the refrigerator.

Transfer an impinger sample quantitatively to a 25-mL volumetric flask and make up to volume with ACN. Pipet aliquots into sample vials and load on the tray of automatic sampler for HPLC analysis.

Stability: Standard solutions of DNPH derivatives in ACN are stable when stored in the refrigerator for several weeks. Reproducibility of formaldehyde, acetaldehyde, acrolein, acetone, propionaldehyde, benzaldehyde and hexanaldehyde standards as derivatives at 4 ug/mL level at about 5% RSD (31 runs over 3.5 months) has been achieved in the past. Reproducibility of a 15-carbonyl calibration mix was about 2% RSD at 0.5- 1 ug/mL level (24 runs over 56 days) has likewise been achieved.

With the exception of acrolein, most aldehydes observed in automotive emissions have stable DNPH derivative in DNPH absorbing solution. Acrolein-DNPH was observed to degrade with time, as much as 20% in 10 hours and up to 50 % in 34 hours (Figure 6).

Compound Identification: The carbonyl compounds in the samples were identified by comparison of their retention times with those of standard samples. Formaldehyde, acetaldehyde, acetone, propionaldehyde, crotonaldehyde, benzaldehyde and o-,m-,p-tolualdehydes were identified with high degree of confidence. The identity of butyraldehyde is less certain because it coelutes with iso-butyraldehyde and methyl-ethyl ketone under our chromatographic conditions. In order to get a reasonable estimate of the total carbonyl content, unknown peaks between propionaldehyde and crotonaldehyde are assigned the response factor and carbon number of propionaldehyde and collectively called u-propionaldehyde. An important exception is an unknown peak in this region which we observed recently to be quantitatively correlated with the disappearance of acrolein. This peak is tentatively identified as x-acrolein and is assigned the response factor and carbon number of acrolein. Unknown peaks between crotonaldehyde and benzaldehyde are assigned the response

factor and carbon number of butyraldehyde. Unknown peaks between benzaldehyde and o-tolualdehyde are assigned the response factor and carbon number of valeraldehyde and unknown peaks adjacent to 2,5-dimethylbenzaldehyde are assigned the response factor and carbon number of 2,5-dimethylbenzaldehyde. Other minor components have been observed to elute much later than 2,5-dimethylbenzaldehyde but have not been identified nor assigned carbon numbers for lack of appropriate standards.

Calculations:

1. Exhaust Emissions Samples

The concentration A_i in parts per million carbon (ppmC, v/v) and mass emission rate B_i in mg/mile of the i th aldehyde are calculated according to the following equations:

$$A_i = (C_i * V_s * RT * N_i) / (t * f * M_i * P) \quad (1)$$

$$B_i = ((C_i * V_s * Q_i * V_{mix}) / (t * f * D)) * 28317. \quad (2)$$

where C_i = concentration in ug/mL of the DNPH derivative of the i th aldehyde in the sample solution

V_s = volume of sample solution in mL

R = gas constant in L-atm-deg⁻¹-mole⁻¹

T = temperature in degree K

N_i = number of carbon atoms in a molecule of the i th aldehyde

t = sampling time or test cycle time in minutes

f = flow rate in liters per minute

M_i = molecular weight of the DNPH derivative of the i th aldehyde

P = total pressure in atmospheres

V_{mix} = total volume of diluted exhaust in cubic feet

Q_i = ratio of molecular weights of the i th aldehyde to its DNPH derivative

D = total mileage for the test cycle

28317 = conversion factor from cubic foot to mL

2. Ambient Air or Diluted Exhaust Samples

The concentration Am_i in parts per million (ppm, v/v) or concentration Ab_i in parts per billion (ppb, v/v) of the i th aldehyde is calculated according to the following equations:

$$Am_i = (C_i * V_s * RT) / (t * f * M_i * P) \quad (3)$$

$$Ab_i = Am_i * 1000 \quad (4)$$

where C_i = concentration in ug/mL of the DNPH derivative of the i th aldehyde in the sample solution

V_s = volume of sample solution in mL

R = gas constant in L-atm-deg⁻¹-mole⁻¹

T = temperature in degree K

t = sampling time in minutes

f = flow rate in liters per minute

M_i = molecular weight of the DNPH derivative of the i th aldehyde

P = total pressure in atmospheres

These calculations are conveniently done using an electronic spreadsheet. Tables 1 and 2 are examples of a completed data and a report form generated with a Perfect Calc spreadsheet program.

RESULTS AND DISCUSSION

The cartridge and the impinger techniques were compared for sampling carbonyls in diluted automotive exhaust emissions and in ambient air, both indoors and outdoors. Samples were collected with one impinger and one to three parallel cartridges. Some samples were collected with two cartridges in series.

The automotive exhausts were sampled from a CVS (constant volume sampler) dilution tunnel at 0.25 - 1.0 L/min with the cartridges and nominally at 1.0 L/min with the impingers. The vehicles were operated using prescribed driving schedules (FTP and HWFET) on a chassis dynamometer. Three vehicles, each operating with a different fuel (a 90% methanol, 10% gasoline blend; gasoline; and diesel) were used.

Ambient atmospheres were sampled at about 1.0-1.5 L/min with one cartridge or about 0.8 L/min with two cartridges in series. Flow rates with the impingers were 2 L/min for a one-hour and about 0.5 L/min for a 12-hour sampling time. Ambient air samples

were collected at three different sites : an analytical laboratory, a parking lot, and a residential area where there was high concentration of wood-burning fireplaces.

All samples were processed according to procedures detailed in the Experimental Section.

For the same volume of air sampled, the final analytical solution from the cartridge for HPLC analysis is five times as concentrated as the analytical solution from the impinger under our present procedures.

Since the DNPH/ACN method has already been validated by several investigators for sampling carbonyl compounds in dilute automotive exhaust emissions and in ambient air, it is taken to be the reference method in the evaluation of the cartridge technique. The evaluation proceeded in two steps: (1) a qualitative comparison was made of the HPLC carbonyl profiles of air samples simultaneously collected with the cartridge and impinger devices and (2) a quantitative comparison of the individual carbonyl species in both samples was determined.

Carbonyl Profiles of Some Air Samples.

Figures 7 and 8 show HPLC chromatograms of diluted exhaust emissions from a methanol powered vehicle. The sampling rates through the cartridge and through the impinger were adjusted to give roughly the same concentrations of the analytes in the HPLC analytical solutions. The carbonyl profiles of the cartridge and impinger samples collected in parallel are very similar. Formaldehyde is the most abundant carbonyl present in the exhaust. The identity of the prominent peak between DNPH and formaldehyde is not known at present. The cartridge sample show slightly more peaks than the impinger as a consequence of higher degree of preconcentration.

The standby cartridge was a blank cartridge connected in parallel with the sampling cartridges during sampling. The output end of the standby cartridge was plugged with a glass rod while the input end was exposed to the diluted exhaust. The purpose of the standby cartridge was to determine background correction due to possible carbonyl permeation through the plastic wall and diffusion into the input end of the cartridge. As can be seen, the impurity level in the standby cartridge is about the same as in the back-up cartridge. About the same level of impurity was also observed in an unexposed cartridge blank. This implies efficient collection of the carbonyl compounds by the first cartridge. No breakthroughs of carbonyls compound into the second cartridge were observed in subsequent samplings with double cartridges at maximum sampling rate. Note also that the concentration of DNPH in both the cartridge and impinger analytical solutions are about the same.

Figure 9 shows carbonyl profiles of exhaust emissions from a gasoline-powered vehicle. With the exception of the C₃ and C₄

regions, the general features of the cartridge and impinger samples are similar. The ratio of acrolein to acetone in the impinger sample is much higher than the corresponding ratio in the cartridge sample. Moreover, a relatively abundant peak (labelled x-acrolein) eluting after propionaldehyde, is observed in the cartridge, but not in fresh impinger samples. When the impinger sample was allowed to stand at room temperature for several hours (see Figure 10), the acrolein peak decreased and another peak appeared in about the same retention time as x-acrolein in the cartridge sample. In fact, the peak distribution of the impinger sample after 28 hours is looking similar to that of the cartridge sample. The disappearance of acrolein peak is accompanied by the growth of x-acrolein peak. If acrolein and x-acrolein are kinetically and/or thermodynamically related, the sum of the concentrations of both species may be invariant with time. Given enough time, the C_3 profiles of the impinger and cartridge sample should look the same. This is indeed the case as shown in the profiles of a parallel set of analytical solutions of cartridge and impinger samples that were stored in the refrigerator for eight months (Figure 13).--Quantitative data supporting the apparent invariance of the sum of concentrations of acrolein and x-acrolein will be given later.

Figure 11 shows carbonyl profiles of diluted exhaust emissions from a diesel vehicle. The similarity of the impinger and cartridge profiles is apparent. Note the relative distribution of acrolein and x-acrolein in both samples. Under our original chromatographic conditions (see Figure 1 caption), x-acrolein was not resolved from propionaldehyde, nor was benzaldehyde from its neighbor. With the impinger, the relative distribution of the C_3 -carbonyls were acrolein > acetone > propionaldehyde. A reversed distribution was observed with the cartridge sample. However, the shape of the propionaldehyde peak strongly suggested the presence of a second peak. The gradient program was subsequently modified to separate this component. Comparison of the profiles indicated that the peak ratios of acetone to propionaldehyde in both samples were about equal. Furthermore, although the peak heights of acrolein and the unknown peak were different in the impinger and cartridge samples, their sums appeared to vary in direct proportion to the volume of sample passed through the corresponding sampling device. These observations strongly suggest that x-acrolein must be a transformation product of acrolein-DNPH. Supporting quantitative data will be presented later in summary tables.

Figure 12 shows carbonyl profiles of air samples in an analytical chemistry laboratory collected with DNPH-coated silica cartridges. The upper sample was collected for 12 hours; the middle, for 2 hours. Volumes of samples collected were 1274 and 205 liters respectively. The concentration of formaldehyde is about 2.5 ppb.

Figure 13 shows profiles of parallel impinger and cartridge samples of dilute exhaust emissions from a gasoline vehicle after storage in the refrigerator for eight months. The peak

distributions from formaldehyde to the end of the chromatogram are almost identical in the two samples, except in the C₄ carbonyl region. The intensities of the two unknown peaks between the DNPH and the formaldehyde peaks are greater in the impinger than in the cartridge sample.

Figure 14 shows profiles of an ambient air sample from a residential site in Raleigh with high concentration of woodburning fireplaces. Both the impinger and the cartridge samples were collected for twelve hours. Sampling rate through the impinger was limited to about 0.5 L/min. due to solvent evaporation. Although the distribution of the major carbonyls in both samples are about the same, the profiles clearly show that a much higher degree of analytical sensitivity can be achieved with cartridge than with impinger sampling. The high sensitivity was achieved because a larger volume of air was sampled by the cartridge and in addition the trapped carbonyls were dissolved in a smaller volume of ACN. As a consequence, the analytes in the cartridge sample can be measured much more precisely than in the corresponding parallel impinger sample.

Figure 15 shows carbonyl profiles of different ambient air samples collected with DNPH-coated silica cartridges. The same volumes of a residential indoor and outdoor air were sampled. The profiles clearly show that indoor air contains significantly higher levels of major carbonyl pollutants relative to the immediate outdoor ambient air. The peak adjacent to acetaldehyde in the outdoor air profile has also been observed in samples of laboratory air (Figure 12, 16), of air outside of a research laboratory building (Figure 18), and more recently, in air samples taken with an aircraft (Figure 17). The relative concentration of this species with respect to formaldehyde, acetone or acetaldehyde for the aircraft sample is much higher than at ground level. Note also the relative abundance of the specie eluting at about the same time as butyraldehyde. For reference, the concentration of formaldehyde in these samples is about 0.3 ppb. Time and location of the air mass sampled by the aircraft were selected to be representative of the previous day sunlight irradiation. It would be very informative to identify this specie and determine whether it plays a role in atmospheric photochemical reaction.

Figure 16 shows background impurities observed in two randomly selected cartridges from a recent lot of DNPH-coated silica cartridges. The identity of the main impurity peak is not known at present. It elutes in a clear window and is easily identified in the profile of an ambient laboratory air sample. It does not interfere with the quantitation of the known carbonyl compounds.

Figure 18 shows comparative profiles of an ambient air sample outside of a research laboratory building (ERC, EPA-RTP) collected on August 14, 1985, and an air sample in an analytical laboratory inside the same building collected on August 1, 1985. Note in particular the relative abundance of formaldehyde,

acetaldehyde, butyraldehyde, acetone and the unknown specie eluting just before acetaldehyde. The carbonyl distribution of the outside air shows strong resemblance to that of the samples taken at high altitude (see Figure 17).

Quantitative Comparison of Cartridge and Impinger for Sampling Carbonyls in Air:

Tables 3a-3c summarize results from sampling diluted exhaust emissions from a gasoline-powered vehicle that was operated under FTP and HWFET test schedules. For DNPH derivatives known to be stable (formaldehyde, acetaldehyde, acetone, propionaldehyde, benzaldehyde and the tolualdehydes) very good agreement between the cartridge and impinger values is obtained. Agreement in the C₄ region (crotonaldehyde and butyraldehyde, especially the latter) is not as good. Peak area integration in this region is not as precise as the other regions due to low concentrations of the species. Complication is further introduced by the presence of unidentified components in this region (see Figures 9 and 10).

The major disagreement between the cartridge and the impinger results is in the case of acrolein. The impinger values are much higher than the cartridge values. Duplicate cartridge samples do not even agree (see Table 3c). However, when the concentration of acrolein is added to that of the unknown peak, previously identified as x-acrolein, the agreement of the sum is excellent between the cartridge and impinger. The same is true in the case of duplicate cartridges.

The quantitative relationship between acrolein and x-acrolein in an impinger sample is shown Table 3d. The disappearance of acrolein is accompanied by the formation of x-acrolein, almost on a mole for mole basis, and the sum of both specie appears to be invariant with time. Although this data is very limited, it lends support to our initial conclusions that x-acrolein must be a degradation product of acrolein and that the sum of acrolein and x-acrolein at any one time can possibly be used to estimate an accurate integrated concentration of acrolein.

Comparing normalized concentrations of the individual carbonyl compounds relative to formaldehyde in the cartridge and impinger samples is another way of comparing both sampling techniques. This factors out sample size in the comparison and most of the experimental errors resulting from small variations in flow. Moreover, it is also helpful in flagging carbonyl species that may degrade in the sample matrix or maybe formed as sampling artifacts. For stable species, the normalized concentrations should be about equal for samples collected by both techniques. This is basically true across the board for formaldehyde, acetaldehyde, acetone, propionaldehyde, benzaldehyde and the tolualdehydes. Acrolein, is readily spotted as an oddball, and so is x-acrolein. Their corresponding sums, however, reasonably agree within experimental uncertainty.

Basically, similar observations can be made of the data from the diesel-powered and methanol-powered vehicles (Tables 4a-4c, Tables 5a-5c). The invariance of the sum of acrolein and x-acrolein is measured in these tables in terms of the sum of acrolein and propionaldehyde. As noted, the HPLC conditions used did not resolve x-acrolein from propionaldehyde.

Table 6 summarizes the results of comparison of cartridge and impinger techniques for sampling diluted exhaust emissions from three types of vehicles. Stable carbonyls (formaldehyde, acetaldehyde, acetone, propionaldehyde, benzaldehyde and the tolualdehydes) have mean cartridge to impinger ratios of about 1.00 and RSD range of about 4-30% for the gasoline vehicle. The high scatter is associated with carbonyls present at low ppb levels. Acrolein has the lowest (0.38) and x-acrolein, the highest (3.47) mean ratio. Scatter for these two species, at 48 and 63% RSD respectively, is also high. The mean ratio (0.92) of the sum is more in line with those of the stable species and the scatter, 14.7% RSD, falls within range as well. Crotonaldehyde is the only other carbonyl compound in the gasoline exhaust emissions that shows a significant difference in the ratio of the two approaches. Like acrolein, crotonaldehyde is an olefinic aldehyde. Its DNPH derivative can conceivably undergo the same chemical transformations as that of acrolein derivative. Its concentration level is approximately one fifth to one seventh that of acrolein.

Acrolein again has the lowest mean cartridge to impinger ratio (0.35) and the highest scatter (53.3% RSD) among the major carbonyls in diesel exhaust emissions. These values are practically the same as those in the gasoline exhaust emissions. The propionaldehyde mean ratio (3.52) appears to be abnormally high. As noted in Tables 4a-4c, however, there is significant contribution from x-acrolein as this specie was not resolved from propionaldehyde under the chromatographic conditions used. An excellent correlation is obtained when the corresponding sums of acrolein and propionaldehyde are compared.

Very good correlations were obtained between cartridge and impinger mean ratios for formaldehyde (1.04) and acetaldehyde (1.08) in exhaust emissions from a methanol vehicle. Percent RSD is within 10% for both species. Data for the other carbonyls show high scatter principally due to low concentrations of the species (see Figures 7-8, Tables 5a-5c).

Table 7a illustrates cartridge reproducibility for extended (12 hr) sampling of carbonyls in an analytical laboratory ambient air. Table 7b compares impinger and cartridge for short term sampling (1 hr) of an analytical laboratory ambient air. Agreement between the two sampling methods is good considering the low concentrations of the species involved. Table 7c compares the impinger and cartridge for long term (12 hr) sampling of an outdoor ambient air at winter time. Excellent correlation between Cart 1 and Cart 2 indicates a single

cartridge is adequate for sampling carbonyls in ambient air at these concentration levels. The correlation between the impinger and the parallel cartridges is good.

Table 7d gives data obtained for two consecutive 12-hr sampling of an outdoor ambient air. The carbonyl concentrations during the day were consistently low. A significant increase in carbonyl levels was observed for the night samples with the peak levels occurring between 8:00 P.M. and 2:00 A.M. This time frame corresponded to heavy usage of woodburning fireplaces in this residential site. The night time data also illustrates the internal consistency of cartridge sampling, i.e. the whole is the sum of its parts. The integrated 12-hr concentration of the carbonyls calculated from data obtained for two consecutive 6-hr sampling episodes agree very well with the experimental values for a continuous 12-hr sample.

Table 8 presents some of the early data that were obtained in the initial application of the cartridge technique for sampling carbonyls in ambient air at winter time. In Runs 1-3, the cartridges were used as direct probes and traps. The collection efficiency of the cartridge, especially for formaldehyde, significantly decreased when the collection temperature was near or below 0°C. Cartridge samplings were thereafter performed with a heated probe. A significant improvement in collection efficiency was observed (see Run 4).

Table 9 presents some data on stability of ambient air samples on transit by mail from EPA/RTP to the west coast and back and on storage in the refrigerator. The data set is very limited. However, it appears that a sample when properly packaged, can be sent from the field to a central laboratory for analysis within about two weeks without compromise of sample integrity. The sample can be likewise stored in a refrigerator for over a month (Table 9b) without apparent deleterious effects.

Florisil, coated with DNPH, in cartridge sampling devices, was reported to be a good trap for collecting formaldehyde in air. Three new Florisil Sep-PAK cartridges and about a dozen used ones, were coated with acidified DNPH according to procedures describe in this report. About 50 silica cartridges were also coated at the same time. Parallel samples of laboratory air were collected with DNPH coated Florisil and silica cartridges and analyzed by HPLC. Carbonyl profiles of the samples are shown in Figures 19 and 20. Quantitative results are summarized in Table 10. The following observations were noted:

1. Both the silica and the Florisil Sep-PAKs were charged with the same amounts of acidified DNPH. However, on elution with ACN, more DNPH was eluted from the silica than from the Florisil Sep-PAK (see the profiles of the blanks in Figures 19 and 20). That DNPH was retained in the Florisil cartridge was apparent from a persistent yellow coloration on the particles after the elution. This residual coloration could not be eluted with either methanol or methylene chloride nor with ACN acidified

with perchloric acid (1 mL of 3.8 M HClO₄ per 100 mL ACN). The silica Sep-PAK were colorless after elution with ACN.

2. More DNPH was eluted from a reclaimed (previously coated and used) Florisil cartridge than from a new cartridge (unused and coated for the first time). See profiles of blank Florisil cartridges in Figures 19 and 20.

3. The DNPH-coated Florisil exhibits high specificity for trapping formaldehyde. Formaldehyde values compare favorably with those from silica samples (see Table 10). It is not clear from the limited data whether the other carbonyls are not efficiently trapped, or are efficiently trapped but irreversibly bound in the sorbent matrix.

CONCLUSIONS

1. Qualitative and quantitative experimental data show that the DNPH-coated silica cartridge and DNPH/ACN impinger methods for sampling carbonyl compounds in air are equivalent.

2. Significantly higher analytical sensitivity is attainable with the cartridge method due to high degree of preconcentration of the analytes in the HPLC analytical samples.

3. A quantitative correlation has been shown between the disappearance of acrolein in a sample matrix and the growth of an unknown component, x-acrolein. The sum of the concentration of acrolein and x-acrolein appears to be invariant with time and could possibly be used to measure the true concentration of acrolein.

4. A heated probe is absolutely necessary when sampling carbonyl compounds in air with DNPH-coated silica cartridges when the ambient temperature is below or near freezing.

5. The cartridge is more convenient than the impinger for field applications especially when the samples have to be shipped to a central laboratory for analysis.

6. Cartridge samples, when properly packed, can be shipped from the field to a central laboratory within two weeks without sacrifice of sample integrity. Samples can be stored in a refrigerator for a month without significant deterioration.

7. Mass flow controllers are highly recommended for cartridge sampling.

8. Florisil when coated with acidified DNPH according to procedures developed for the silica cartridge show high specificity for formaldehyde. There appears to be problems with the collection and/or elution of the other carbonyls.

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FIGURE CAPTIONS

Figure 1. HPLC profile of absorbing solution prepared from "purified" DNPH crystals. Conditions: Column, two duPont Zorbax ODS (4.6x250 mm) columns in series; detection at 360 nm; sample volume, 25 mL; flow rate, 1 mL/min; gradient program, on injection, linear gradient from 60% to 100% acetonitrile in water in 40 min, linear gradient from 100% to 60% in 5 min, isocratic at 60% for 15 min.

Figure 2. Apparatus for rinsing purified DNPH crystals and for preparing, storing, and dispensing of saturated DNPH stock solution for routine carbonyl analysis.

Figure 3. Configuration for carbonyl sampling of automotive exhaust emissions.

Figure 4. Chromatographic separation of DNPH derivatives of 15 carbonyl standards. Conditions as in Figure 1. Peak identities (concentration, ppm) of the derivatives are: 1 - formaldehyde (1.14); 2 - acetaldehyde (1.00); 3 - acrolein (1.00); 4 - acetone (1.00); 5 - propionaldehyde (1.00); 6 - crotonaldehyde (1.00); 7 - butyraldehyde (0.905); 8 - benzaldehyde (1.00); 9 - isovaleraldehyde (0.450); 10 - valeraldehyde (0.485); 11 - ortho-tolualdehyde (0.515); 12 - meta-tolualdehyde (0.505); 13 - para-tolualdehyde (0.510); 14 - hexanaldehyde (1.00); 15 - 2,5-dimethylbenzaldehyde (0.510). Bottom trace is that of the same standard mix diluted 50 times.

Figure 5. Chromatographic separation of a 15 carbonyl standard using conditions described in "Optimization of Chromatographic Conditions" section. (See text.)

Figure 6. Degradation of acrolein DNPH derivative in absorbing solution acidified with 3.8M perchloric acid.

Figure 7. Chromatographic profiles of FTP Bag 1 diluted exhaust from a methanol fueled car collected using two cartridges in series. Chromatographic conditions as in Figure 4.

Figure 8. Comparison of impinger and cartridge collection techniques for FTP Bag 1 diluted exhaust from a methanol car. Chromatographic conditions as in Figure 4.

Figure 9. Comparison of impinger and cartridge collection techniques for FTP Bag 1 diluted exhaust from a gasoline fueled car. Conditions as in Figure 5.

Figure 10. Chromatographic profiles of an impinger sample of an FTP Bag 1 diluted exhaust showing the appearance of degradation product of acrolein. Conditions as in Figure 5.

Figure 11. Comparison of impinger and cartridge collection techniques for sampling HWFET diluted exhaust from a light duty diesel car.

Figure 12. Carbonyl profiles of laboratory air sampled for 12 hours (1274 liters total volume) and 2 hours (205 liters total volume) using the cartridge technique. Formaldehyde concentration is about 2.5 ppb (v/v).

Figure 13. Profiles of analytical solutions, after storage in a refrigerator for eight months, of a parallel cartridge and impinger samples of an exhaust emissions from a gasoline-powered vehicle.

Figure 14. Profiles of parallel cartridge and impinger ambient air samples at a wood smoke impacted residential site demonstrating the analytical sensitivity advantage of the cartridge collection technique.

Figure 15. Profiles of different ambient air samples collected with DNPH-coated cartridge. The second and third trace from the top were taken from a residential house.

Figure 16. Profiles of two blank DNPH-coated cartridges from the same lot, illustrating reproducibility of coating procedure. The uppermost trace is a laboratory air sample collected with a cartridge from the same lot.

Figure 17. Profiles of ambient air samples collected at high altitudes (AUG7A3 and AUG7A2). Trace AUG7A5 is that of blank cartridge. Ambient formaldehyde level is about 0.3 ppb.

Figure 18. Profiles of ambient air samples from a parking lot collected on 8/1 and 8/14.

Figure 19. Comparative profiles of samples collected with recycled Florisil Sep-PAK and silica Sep-PAK cartridges. Both types of cartridges were coated with the same amount of acidified DNPH.

Figure 20. Same as Figure 19, except the Florisil cartridges were new, i.e. coated with acidified DNPH for the first time.

Table 1. An Example of a Completed Aldehyde Data Entry Form

Q120-S1 Run 1

ALDEHYDE DATA

Run/Sample No.	1.000	Sampling Date:	850801
Test Cycle	0	Sampled by:	SBT
Ambient = 0		Analysis Date:	850801
FTP Bag1 = 1		Analyzed by:	SBT
FTP Bag2 = 2		Sampling Method:	1
FTP Bag3 = 3		Impinger = 0	
HWFET = 4		Cartridge = 1	
NYCC = 5	Sampling Rate, L/min =		1.20
CUE = 6	Sampling Time, min =		90.00
SS = 7	Solution Volume, mL =		5.00
	Pressure, mm Hg =		760.00
	Temperature, deg. C =		25.00
	Sample Volume, L =		108.00

	Calibration Data		Sample Data	
	DNPH-Ald. ppm, soln	P. Height or Area	P. Height or Area	Blank
Formaldehyde	6.860	823369	187304	3496.00
Acetaldehyde	2.030	318598	61881	4692.00
Acrolein	0.892	170419	5462	0
Acetone	0.485	76251	157213	2240.00
Propionaldehyde	0.409	64964	8973	1037.00
Crotonaldehyde	0.440	82663	3932	0
Butyraldehyde	0.756	88704	36880	7460.00
Benzaldehyde	0.442	75679	1652	0
Isovaleraldehyde	0.339	47000	0	0
Valeraldehyde	0.391	49535	294	0
o-Tolualdehyde	0.429	60712	0	0
m-Tolualdehyde	0.389	58408	0	0
p-Tolualdehyde	0.284	75611	0	0
Hexanaldehyde	0.336	53868	3555	0
2,5-Dimethylbenzaldehyde	0.378	57732	0	0
x-Propionaldehyde	0.409	64964	0	0
x-Butyraldehyde	0.756	88704	14925	0
x-Valeraldehyde	0.391	49535	1597	0
x-Dimethylbenzaldehyde	0.378	57732	0	0
x-Acrolein	0.892	170419	0	0
x-Hexanaldehyde	0.336	53868	0	0

Table 2. An Example of a Completed Aldehyde Analytical Result Form
Generated Using an Electronic Spreadsheet

Q120-S1 Run 1

ALDEHYDE REPORT

Run/Sample No.	1	Sampling Date:	85080
Test Cycle	0	Sampled by:	SBT
Ambient = 0		Analysis Date:	850801
FTP Bag1 = 1		Analyzed by:	SBT
FTP Bag2 = 2		Sampling Method:	1
FTP Bag3 = 3		Impinger = 0	
HWFET = 4		Cartridge = 1	
NYCC = 5	Sampling Rate, -L/min =	1.20	
CUE = 6	Sampling Time, min =	90.00	
SS = 7	Solution Volume, mL =	5.00	
	Pressure, mm Hg =	760.00	
	Temperature, deg. C =	25.00	
	Sample Volume, L =	108.00	

Experimental Data
Peak Height or Area

Calculated Data
Concentration in ppb

	Sample	Blank	Sample	Blank	Final
Formaldehyde	187304	3496	8.42	0.16	8.26
Acetaldehyde	61881	4692	1.99	0.15	1.84
Acrolein	5462	0	0.14	0	0.14
Acetone	157213	2240	4.76	0.07	4.69
Propionaldehyde	8973	1037	0.27	0.03	0.24
Crotonaldehyde	3932	0	0.09	0	0.09
Butyraldehyde	36880	7460	1.41	0.29	1.13
Benzaldehyde	1652	0	0.04	0	0.04
Isovaleraldehyde	0	0	0	0	0
Valeraldehyde	294	0	0.01	0	0.01
o-Tolualdehyde	0	0	0	0	0
m-Tolualdehyde	0	0	0	0	0
p-Tolualdehyde	0	0	0	0	0
Hexanaldehyde	3555	0	0.09	0	0.09
2,5-Dimethylbenzaldehyde	0	0	0	0	0
x-Propionaldehyde	0	0	0	0	0
x-Butyraldehyde	14925	0	0.57	0	0.57
x-Valeraldehyde	1597	0	0.05	0	0.05
x-Dimethylbenzaldehyde	0	0	0	0	0
x-Acrolein	0	0	0	0	0
x-Hexanaldehyde	0	0	0	0	0
(Acrolein + x-Acrolein)					0.14
(Acrolein + x-Acrolein + Propionaldehyde)					0.37

Table 3a. Comparison of Cartridge and Impinger for Sampling Diluted Exhaust Emissions from a Gasoline-Powered Vehicle

Concentration in ppb				
	** FTP, Bag #1 **		** FTP, Bag #2 **	
	- Impinger	Cartridge	Impinger	Cartridge
Formaldehyde	1255.98	1224.94	257.46	247.08
Acetaldehyde	175.67	178.08	32.85	29.77
Acrolein	69.71	14.26	3.36	
Acetone	87.07	94.46	39.93	36.96
Propionaldehyde	13.53	25.17		1.48
Crotonaldehyde	14.08	7.27		
Butyraldehyde		18.35		
Benzaldehyde	60.51	64.48	4.35	
o-Tolualdehyde	12.35	10.80		
m-Tolualdehyde	31.39	24.89		
p-Tolualdehyde	8.28	6.99		
x-Butyraldehyde	23.98	36.51		
x-Acrolein		57.65		2.34
Acrolein + x-Acrolein	69.71	71.91	3.36	2.34
Acr + x-Acr + Prop	83.24	97.08	3.36	3.82
Sampling flow, L/min	0.96	0.28	0.96	0.27
Sampling time, min	8.42	8.42	14.53	14.53

Conc. Relative to Formaldehyde				
	** FTP, Bag #1 **		** FTP, Bag #2 **	
	Impinger	Cartridge	Impinger	Cartridge
Formaldehyde	1.0000	1.0000	1.0000	1.0000
Acetaldehyde	0.1399	0.1454	0.1276	0.1205
Acrolein	0.0555	0.0116	0.0131	0
Acetone	0.0693	0.0771	0.1551	0.1496
Propionaldehyde	0.0108	0.0205	0	0.0060
Crotonaldehyde	0.0112	0.0059	0	0
Butyraldehyde	0	0.0150	0	0
Benzaldehyde	0.0482	0.0526	0.0169	0
o-Tolualdehyde	0.0098	0.0088	0	0
m-Tolualdehyde	0.0250	0.0203	0	0
p-Tolualdehyde	0.0066	0.0057	0	0
x-Butyraldehyde	0.0191	0.0298	0	0
x-Acrolein	0	0.0471	0	0.0095
Acrolein + x-Acrolein	0.0555	0.0587	0.0131	0.0095
Acr + x-Acr + Prop	0.0663	0.0793	0.0131	0.0155

Table 3b. Comparison of Cartridge and Impinger for Sampling Diluted Exhaust Emissions from a Gasoline-Powered Vehicle

Concentration in ppb				
	** FTP, Bag #3 **		** HWFET, Run #1 **	
	- Impinger	Cartridge	Impinger	Cartridge
Formaldehyde	733.00	736.93	1109.05	1092.31
Acetaldehyde	99.28	105.09	144.33	130.96
Acrolein	25.58	6.96	39.96	19.18
Acetone	58.27	66.30	82.32	73.40
Propionaldehyde	7.77	9.97	6.70	7.75
Crotonaldehyde			3.43	2.56
Butyraldehyde		13.66		8.06
Benzaldehyde	31.45	30.54	32.33	28.65
o-Tolualdehyde		4.40	4.83	5.23
m-Tolualdehyde	9.50	14.23	15.71	12.46
p-Tolualdehyde		4.35	4.31	3.48
x-Butyraldehyde	9.92	15.85	19.21	24.70
x-Acrolein	3.90	24.70	6.12	24.03
Acrolein + x-Acrolein	29.48	31.66	46.08	43.21
Acr + x-Acr + Prop	37.25	41.63	52.78	50.96
Sampling flow, L/min	0.96	0.28	0.96	0.28
Sampling time, min	8.53	8.53	12.75	12.75

Concentration Relative to Formaldehyde

	** FTP, Bag #3 **		** HWFET, Run #1 **	
	Impinger	Cartridge	Impinger	Cartridge
Formaldehyde	1.0000	1.0000	1.0000	1.0000
Acetaldehyde	0.1354	0.1426	0.1301	0.1199
Acrolein	0.0349	0.0094	0.0360	0.0176
Acetone	0.0795	0.0900	0.0742	0.0672
Propionaldehyde	0.0106	0.0135	0.0060	0.0071
Crotonaldehyde	0	0	0.0031	0.0023
Butyraldehyde	0	0.0185	0	0.0074
Benzaldehyde	0.0429	0.0414	0.0292	0.0262
o-Tolualdehyde	0	0.0060	0.0044	0.0048
m-Tolualdehyde	0.0130	0.0193	0.0142	0.0114
p-Tolualdehyde	0	0.0059	0.0039	0.0032
x-Butyraldehyde	0.0135	0.0215	0.0173	0.0226
x-Acrolein	0.0053	0.0335	0.0055	0.0220
Acrolein + x-Acrolein	0.0402	0.0430	0.0415	0.0396
Acr + x-Acr + Prop	0.0508	0.0565	0.0476	0.0467

Table 3c. Comparison of Cartridge and Impinger for Sampling Diluted Exhaust Emissions from a Gasoline-Powered Vehicle

Concentration in ppb			
***** HWFET, Run #2 *****			
	Impinger	Pump #1 Cartridge	Pump #2 Cartridge
Formaldehyde	1065.68	1082.88	1135.30
Acetaldehyde	137.07	126.77	136.63
Acrolein	30.68	19.62	8.60
Acetone	76.43	72.23	76.45
Propionaldehyde	10.23	8.52	9.77
Crotonaldehyde	4.73	1.50	1.85
Butyraldehyde		9.51	10.39
Benzaldehyde	27.65	26.13	29.16
o-Tolualdehyde		4.89	6.26
m-Tolualdehyde	12.13	13.52	14.81
p-Tolualdehyde	3.06	3.50	3.52
x-Butyraldehyde	27.03	24.94	27.75
x-Acrolein	14.12	18.45	32.58
Acrolein + x-Acrolein	44.80	38.07	41.18
Acr + x-Acr + Prop	55.03	46.59	50.95
Sampling flow, L/min		0.28	0.28
Sampling time, min		12.75	12.75

Conc. Relative to Formaldehyde

***** HWFET, Run #2 *****			
	Impinger	Pump #1 Cartridge	Pump #2 Cartridge
Formaldehyde	1.0000	1.0000	1.0000
Acetaldehyde	0.1286	0.1171	0.1203
Acrolein	0.0288	0.0181	0.0076
Acetone	0.0717	0.0667	0.0673
Propionaldehyde	0.0096	0.0079	0.0086
Crotonaldehyde	0.0044	0.0014	0.0016
Butyraldehyde	0	0.0088	0.0092
Benzaldehyde	0.0259	0.0241	0.0257
o-Tolualdehyde	0	0.0045	0.0055
m-Tolualdehyde	0.0114	0.0125	0.0130
p-Tolualdehyde	0.0029	0.0032	0.0031
x-Butyraldehyde	0.0254	0.0230	0.0244
x-Acrolein	0.0132	0.0170	0.0287
Acrolein + x-Acrolein	0.0420	0.0352	0.0363
Acr + x-Acr + Prop	0.0516	0.0430	0.0449

Table 3d. Invariance of the Sum of Concentrations of Acrolein and x-Acrolein Observed in an Impinger Sample of Exhaust Emissions from a Gasoline Fueled Vehicle.

<u>Time (hr)</u>	<u>Concentration in ppb</u>		
	<u>Acrolein</u>	<u>x-Acrolein</u>	<u>Sum</u>
0	58.5	0	58.5
25	46.6	11.7	58.3
35	42.2	12.9	55.1

Table 4a. Comparison of Cartridge and Impinger for Sampling Diluted Exhaust Emissions from a Diesel-Powered Vehicle

Concentration in ppb				
	** FTP, Bag #1 **		** FTP, Bag #2 **	
	Pump #3		Pump #2	
	Impinger	Cartridge	Impinger	Cartridge
Formaldehyde	594.01	619.52	389.32	426.20
Acetaldehyde	139.41	143.46	101.46	99.45
Acrolein	77.35		52.52	26.08
Acetone	41.99	45.43	31.03	28.90
Propionaldehyde	24.30	97.80	15.41	38.75
Crotonaldehyde	23.92	22.78	15.78	18.27
Butyraldehyde	16.96	22.41	9.86	14.60
Benzaldehyde	15.80	25.81	15.09	20.16
Acrol + Propion	101.65	97.80	67.93	64.83
Sampling flow, L/min	0.96	0.28	0.96	0.54
Sampling time, min	8.42	8.42	14.53	14.53

Concentration Relative to Formaldehyde				
	** FTP, Bag #1 **		** FTP, Bag #2 **	
	Pump #3		Pump #2	
	Impinger	Cartridge	Impinger	Cartridge
Formaldehyde	1.0000	1.0000	1.0000	1.0000
Acetaldehyde	0.2347	0.2316	0.2606	0.2333
Acrolein	0.1302	0	0.1349	0.0612
Acetone	0.0707	0.0733	0.0797	0.0678
Propionaldehyde	0.0409	0.1579	0.0396	0.0909
Crotonaldehyde	0.0403	0.0368	0.0405	0.0429
Butyraldehyde	0.0286	0.0362	0.0253	0.0343
Benzaldehyde	0.0266	0.0417	0.0388	0.0473
Acrol + Propion	0.1711	0.1579	0.1745	0.1521

Note: Data were obtained under HPLC conditions that did not resolve x-acrolein from propionaldehyde.

Table 4b. Comparison of Cartridge and Impinger for Sampling Diluted Exhaust Emissions from a Diesel-Powered Vehicle

Concentration in ppb				
	** FTP, Bag #3 **		** HWFET, Run #1 **	
	Pump #3		Pump #3	
	Impinger	Cartridge	Impinger	Cartridge
Formaldehyde	487.02	484.61	528.18	477.90
Acetaldehyde	115.05	108.21	109.17	96.14
Acrolein	64.17	9.37	60.22	8.97
Acetone	34.70	28.71	32.65	25.04
Propionaldehyde	17.10	75.21	13.30	64.04
Crotonaldehyde	21.02	19.29	16.20	15.77
Butyraldehyde	9.50	14.30	10.58	14.43
Benzaldehyde	19.55	22.14	22.39	24.96
Acrol + Propion	81.27	84.58	73.52	73.01
Sampling flow, L/min	0.96	0.28	0.96	0.28
Sampling time, min	8.53	8.53	12.75	12.75

Concentration Relative to Formaldehyde				
	** FTP Bag #3 **		** HWFET, Run #1 **	
	Pump #3		Pump #3	
	Impinger	Cartridge	Impinger	Cartridge
Formaldehyde	1.0000	1.0000	1.0000	1.0000
Acetaldehyde	0.2362	0.2233	0.2067	0.2012
Acrolein	0.1318	0.0193	0.1140	0.0188
Acetone	0.0712	0.0592	0.0618	0.0524
Propionaldehyde	0.0351	0.1552	0.0252	0.1340
Crotonaldehyde	0.0432	0.0398	0.0307	0.0330
Butyraldehyde	0.0195	0.0295	0.0200	0.0302
Benzaldehyde	0.0401	0.0457	0.0424	0.0522
Acrol + Propion	0.1669	0.1745	0.1392	0.1528

Note: Data were obtained under HPLC conditions that did not resolve x-acrolein from propionaldehyde.

Table 4c. Comparison of Cartridge and Impinger for Sampling Diluted Exhaust Emissions from a Diesel-Powered Vehicle

Concentration in ppb				
	** HWFET, Run #2 **		** HWFET, Run #3 **	
	Pump #1		Pump #1	
	Impinger	Cartridge	Impinger	Cartridge
Formaldehyde	498.28	545.29	499.32	524.24
Acetaldehyde	102.03	118.84	102.84	114.28
Acrolein	58.93	28.30	57.78	28.88
Acetone	33.22	32.93	36.05	32.67
Propionaldehyde	18.00	50.79	18.44	47.21
Crotonaldehyde	18.06	18.48	13.75	17.44
Butyraldehyde	10.62	14.83	8.98	16.36
Benzaldehyde	19.91	28.35	23.60	25.04
Acrol + Propion	76.93	79.09	76.22	76.09
Sampling flow, L/min	0.96	0.58	0.96	0.60
Sampling time, min	12.75	12.75	12.75	12.75

Concentration Relative to Formaldehyde				
	** HWFET, Run #2 **		** HWFET, Run #3 **	
	Pump #1		Pump #1	
	Impinger	Cartidge	Impinger	Cartridge
Formaldehyde	1.0000	1.0000	1.0000	1.0000
Acetaldehyde	0.2048	0.2179	0.2060	0.2180
Acrolein	0.1183	0.0519	0.1157	0.0551
Acetone	0.0667	0.0604	0.0722	0.0623
Propionaldehyde	0.0361	0.0931	0.0369	0.0901
Crotonaldehyde	0.0362	0.0339	0.0275	0.0333
Butyraldehyde	0.0213	0.0272	0.0180	0.0312
Benzaldehyde	0.0400	0.0520	0.0473	0.0478
Acrol + Propion	0.1544	0.1450	0.1526	0.1451

Note: Data were obtained with HPLC conditions that did not resolve x-acrolein from propionaldehyde.

Table 5a. Comparison of Cartridge and Impinger for Sampling
Diluted Exhaust Emissions from a Methanol-Powered Vehicle

Concentration in ppb

	***** FTP, Bag #1 *****			** FTP, Bag #2 **	
	Pump #1		Pump #3	Pump #2	
	Impinger	Cartridge	Cartridge	Impinger	Cartridge
Formaldehyde	2382.99	2284.71	2454.63	113.39	88.50
Acetaldehyde	19.58	19.84	21.54	90.92	2.57
Acrolein	6.02	3.39	5.23	3.37	
Acetone	10.96	6.67	8.88	6.35	2.65
Propionaldehyde		1.19	2.18		
Crotonaldehyde			1.42		
Butyraldehyde			3.82		
Benzaldehyde		3.17	3.96		
x-Acrolein					
Acrolein + x-Acrolein	6.02	3.39	5.23	3.37	0
Acr + x-Acr + Prop	6.02	4.58	7.41	3.37	0
Sampling Flow, L/min	0.96	0.58	1.14	0.96	0.54
Sampling time, min	8.42	8.42	8.42	14.53	14.53

Concentration Relative to Formaldehyde

	***** FTP, Bag #1 *****			** FTP, Bag #2 **	
	Pump #1		Pump #3	Pump #2	
	Impinger	Cartridge	Cartridge	Impinger	Cartridge
Formaldehyde	1.0000	1.0000	1.0000	1.0000	1.0000
Acetaldehyde	0.0082	0.0087	0.0088	0.8018	0.0290
Acrolein	0.0025	0.0015	0.0021	0.0297	0
Acetone	0.0046	0.0029	0.0036	0.0560	0.0299
Propionaldehyde	0	0.0005	0.0009	0	0
Crotonaldehyde	0	0	0.0006	0	0
Butyraldehyde	0	0	0.0016	0	0
Benzaldehyde	0	0.0014	0.0016	0	0
x-Acrolein	0	0	0	0	0
Acrolein + x-Acrolein	0.0025	0.0015	0.0021	0.0297	0
Acr + x-Acr + Prop	0.0025	0.0020	0.0030	0.0297	0

Note 1. FTP Bag #2 data for cartridge sample are not reliable due to timer malfunction.

Note 2. Data were obtained under HPLC conditions that did not resolve x-acrolein from propionaldehyde.

Table 5b. Comparison of Cartridge and Impinger for Sampling
Diluted Exhaust Emissions from a Methanol-Powered Vehicle

Concentration in ppb

	***** FTP, Bag #3 *****			** HWFET, Run #2 **	
	Impinger	Pump #1 Cartridge	Pump #3 Cartridge	Pump #1 Cartridge	Pump #3 Cartridge
Formaldehyde	1522.88	1566.91	1853.58	303.68	360.48
Acetaldehyde	23.13	24.13	28.93	4.56	4.08
Acrolein		2.41	4.63		
Acetone	10.77	8.34	10.68	2.73	0.02
Propionaldehyde		1.71	4.57		
Crotonaldehyde					
Butyraldehyde					
Benzaldehyde		2.45			
x-Acrolein					
Acrolein + x-Acrolein	0	2.41	4.63	0	0
Acr + x-Acr + Prop	0	4.12	9.20	0	0
Sampling Flow, L/min	0.96	0.59	1.03	0.58	1.08
Sampling time, min	8.53	8.53	8.53	12.75	12.75

Concentration Relative to Formaldehyde

	***** FTP, Bag #3 *****			** HWFET, Run #2 **	
	Impinger	Pump #1 Cartridge	Pump #3 Cartridge	Pump #1 Cartridge	Pump #3 Cartridge
Formaldehyde	1.0000	1.0000	1.0000	1.0000	1.0000
Acetaldehyde	0.0152	0.0154	0.0156	0.0150	0.0113
Acrolein	0	0.0015	0.0025	0	0
Acetone	0.0071	0.0053	0.0058	0.0090	0.0001
Propionaldehyde	0	0.0011	0.0025	0	0
Crotonaldehyde	0	0	0	0	0
Butyraldehyde	0	0	0	0	0
Benzaldehyde	0	0.0016	0	0	0
x-Acrolein	0	0	0	0	0
Acrolein + x-Acrolein	0	0.0015	0.0025	0	0
Acr + x-Acr + Prop	0	0.0026	0.0050	0	0

Note 1. Corresponding impinger data for HWFET Run #2 are in Table 5c.

Note 2. Data were obtained under HPLC conditions that did not resolve x-acrolein from propionaldehyde.

Table 5c. Comparison of Cartridge and Impinger for Sampling Diluted Exhaust Emissions from a Methanol-Powered Vehicle

Concentration in ppb					
	***** HWFET, Run #1 *****				* HWFET
	Impinger	Pump #1 Cartridge	Pump #2 Cartridge	Pump #3 Cartridge	Run #2 Impinger
Formaldehyde	996.48	951.82	1056.65	1073.31	322.16
Acetaldehyde	11.10	11.26	12.86	11.25	1.41
Acrolein	0.82	1.26	1.52	1.32	
Acetone	3.88	4.88	5.63	2.04	
Propionaldehyde	3.54	0.96	1.07	0.96	
Crotonaldehyde					
Butyraldehyde			1.93		
Benzaldehyde		0.86	1.37		
x-Acrolein					
Acrolein + x-Acrolein	0.82	1.26	1.52	1.32	0
Acr + x-Acr + Prop	4.36	2.22	2.59	2.28	0
Sampling Flow, L/min	0.96	0.56	0.54	1.05	0.96
Sampling time, min	12.75	12.75	12.75	12.75	12.75

Concentration Relative to Formaldehyde					
	***** HWFET, Run #1 *****				* HWFET *
	Impinger	Pump #1 Cartridge	Pump #2 Cartridge	Pump #3 Cartridge	Run #2 Impinger
Formaldehyde	1.0000	1.0000	1.0000	1.0000	1.0000
Acetaldehyde	0.0111	0.0118	0.0122	0.0105	0.0044
Acrolein	0.0008	0.0013	0.0014	0.0012	0
Acetone	0.0039	0.0051	0.0053	0.0019	0
Propionaldehyde	0.0036	0.0010	0.0010	0.0009	0
Crotonaldehyde	0	0	0	0	0
Butyraldehyde	0	0	0.0018	0	0
Benzaldehyde	0	0.0009	0.0013	0	0
x-Acrolein	0	0	0	0	0
Acrolein + x-Acrolein	0.0008	0.0013	0.0014	0.0012	0
Acr + x-Acr + Prop	0.0044	0.0023	0.0025	0.0021	0

Note 1. Corresponding cartridge data for HWFET Run #2 are in Table 5b.

Note 2. Data were obtained under HPLC conditions that did not resolve x-acrolein from propionaldehyde.

Table 6. Summary Comparison of Cartridge and Impinger for Sampling Carbonyl Compounds in Diluted Automotive Exhaust Emissions

Gasoline Vehicle	Cart/Imp Ratio	Sigma	n	Conc. Range (ppb)		RSD
				Low	High	
Formaldehyde	1.00	0.04	6	247	1256	3.7
Acetaldehyde	-0.97	0.06	6	30	178	6.7
Acrolein	0.38	0.18	5	7	69	48.0
Acetone	1.00	0.10	6	37	87	9.7
Propionaldehyde	1.02	0.20	5	7	25	19.2
Crotonaldehyde	0.49	0.19	4	2	14	38.2
Benzaldehyde	0.98	0.08	5	26	65	7.7
o-Tolualdehyde	0.98	0.15	2	4	12	15.1
m-Tolualdehyde	1.08	0.30	5	9	31	27.7
p-Tolualdehyde	0.99	0.19	4	3	8	18.9
x-Butyraldehyde	1.27	0.30	5	9	36	23.3
x-Acrolein	3.47	2.19	4	4	32	63.3
Acr + x-Acr	0.92	0.14	6	2	44	14.7
Acr + x-Acr + Prop	1.03	0.13	6	4	97	12.8

Sample volumes: Impinger = 8-14 L; Cartridge = 2.4-3.9 L

Diesel Vehicle	Cart/Imp Ratio	Sigma	n	Conc. Range (ppb)		RSD
				Low	High	
Formaldehyde	1.03	0.07	6	389	619	7.0
Acetaldehyde	1.02	0.11	6	96	139	10.5
Acrolein	0.35	0.19	5	9	77	53.3
Acetone	0.91	0.11	6	25	45	12.4
Propionaldehyde	3.52	1.01	6	15	97	28.7
Crotonaldehyde	1.05	0.14	6	14	23	13.0
Butyraldehyde	1.49	0.18	6	9	17	11.8
Benzaldehyde	1.28	0.22	6	15	26	17.3
Acr + Prop	1.00	0.03	6	67	101	3.5

Sample volumes: Impinger = 8-14 L; Cartridge = 2.4-7.6 L

Methanol Vehicle	Cart/Imp Ratio	Sigma	n	Conc. Range (ppb)		RSD
				Low	High	
Formaldehyde	1.04	0.09	9	303	2454	8.5
Acetaldehyde	1.08	0.08	7	11	21	4.4
Acrolein	1.29	0.54	5	1	6	42.3
Acetone	0.76	0.41	7	2	10	54.4
Propionaldehyde	0.28	0.02	3	1	3	6.4
Acr + x-Acr	1.20	0.51	5	1	6	43.0
Acr + x-Acr + Prop	0.73	0.30	5	2	7	41.4

Sample volumes: Impinger = 8-14 L; Cartridge = 4.8-13.4 L

Table 7. Concentrations of Carbonyls in Ambient Air Sampled in Parallel with Cartridges and/or Impingers

Table 7a. Laboratory Air, sampled for 12 hours

	Concentration in ppb			Mean	Sigma
	Cart 1	Cart 2	Cart 3		
Formaldehyde	2.67	2.71	2.57	2.65	0.07
Acetaldehyde	1.14	1.15	1.13	1.14	0.01
Acrolein	0.11	0.11	0.11	0.11	0.11
Acetone	3.27	3.28	3.32	3.29	0.03
Propionaldehyde	0.16	0.16	0.16	0.16	0
Butyraldehyde	0.51	0.51	0.59	0.54	0.05
Benzaldehyde	0.04	0.04	0.05	0.04	0.01
Hexanaldehyde	0.07	0.11	0.07	0.08	0.02
x-Butyraldehyde	0.31	0.27	0.24	0.27	0.04
x-Acrolein	0.11	0	0.01	0.04	0.06
Sample volume, L	1274	1548	1416		

Table 7b. Laboratory Air, sampled for one hour

	Concentration in ppb			
	Run 1		Run 2	
	Imp	Cart	Imp	Cart
Formaldehyde	2.75	2.52	4.11	3.75
Acetaldehyde	1.17	1.59	2.16	2.26
Acrolein		0.07	0.12	0.13
Acetone	1.80	2.43	2.52	2.66
Propionaldehyde		0.21	0.16	0.08
Butyraldehyde		1.00		0.12
Sample volume, L	171.00	81.00	165.00	74.70

Table 7c. Ambient Air, IACP Raleigh primary site, sampled for 12 hours with heated probes for impinger and cartridges.

	Concentration in ppb			
	Imp	Cart 1	Cart 2	Cart 3
Formaldehyde	6.29	7.30	7.23	7.38
Acetaldehyde	3.20	4.08	4.05	4.15
Acrolein	1.01	1.14	1.14	1.10
Acetone	3.06	3.67	3.63	3.72
Propionaldehyde	0.36	0.65	0.61	0.60
Crotonaldehyde	0.14	0.32	0.60	0.44
x-Acrolein	0.07		0.27	0.32
Sample volume, L	275	640	907	698
Heated probe?	Yes	Yes	Yes	No
No. of Carts.	Double	Double	Single	Double

Table 7d. Effects of Fireplace Usage on Carbonyl Concentrations
in Ambient Air at the Raleigh IACP Primary Site

Night Samples	Concentration in ppb				Cal/Obs Ratio
	Cart1	Observed Cart2	Cart3	Calculated Cart(1+2)	
Formaldehyde	18.73	8.59	14.17	14.27	1.01
Acetaldehyde	9.98	5.65	7.88	8.07	1.02
Acrolein	2.98	1.66	2.86	2.40	0.84
Acetone	5.62	4.51	4.20	5.13	1.22
Propionaldehyde	0.97	0.78	0.99	0.89	0.90
Crotonaldehyde	0.77	0.53	1.30	0.66	0.51
Butyraldehyde	1.50	1.24	1.20	1.39	1.15
Benzaldehyde	0.41	0.16	0.19	0.30	1.58
x-Butyraldehyde	1.60	1.12	0.33	1.39	4.21
x-Valeraldehyde	1.93	0.50	0.84	1.30	1.55
x-Acrolein	1.14	0.66	0.54	0.93	1.72
Acr + x-Acr	4.12	2.32	3.40	3.33	0.98
Sample volume, L	353	277	1087	630	
No. of Cartridges:	Double	Double	Single		
Sampling Date: 2/16/85					
Start time:	8:00 PM	2:00 AM	8:00 PM	8:00 PM	
End time:	2:00 AM	8:00 AM	8:00 AM	8:00 AM	
Temperature	High = 34		Low = 31		Mean = 32.7

Day Samples	Concentration in ppb			
	Cart1	Cart2	Cart3	
Formaldehyde	2.14	1.94	2.20	
Acetaldehyde	1.19	1.14	1.29	
Acrolein	0.06	0.05	0.07	
Acetone	1.17	NA ^a	1.26	
Propionaldehyde	0.17	0.10	0.19	
Crotonaldehyde				
Butyraldehyde	1.22	1.03	1.05	
Benzaldehyde	0.01		0.01	
x-Butyraldehyde	0.07	0.07	0.09	
x-Valeraldehyde	0.09	0.08	0.07	
x-Acrolein	0.08		0.07	
Acr + x-Acr	0.14	0.05	0.14	
Sample volume, L	640.00	424.00	583.20	
No. of Cartridges:	Double	Single	Double	
Sampling Date: 2/16/85				
Start time:	7:30 AM	7:30 AM	7:30 AM	
End time:	7:30 PM	1:30 PM	7:30 PM	
Temperature	High = 45	Low = 16	Mean = 35.4	

^a NA = not available due to air bubble interference

Note: All samples were collected with a common heated probe.

Table 8. Effects of Low Temperatures on Collection Efficiency of DNPH-Coated Silica Cartridges for Carbonyl Compounds, Assuming that the Impinger is 100% Efficient.

	Run 1		Run 2		Run 3	
	Imp	Cart	Imp	Cart	Imp	Cart
Formaldehyde	4.77	1.03	5.76	4.42	5.16	3.30
Acetaldehyde	0.98	0.60	2.38	2.40	1.97	1.61
Acetone	1.16	1.26	1.85	1.72	1.43	0.90
Buteraldehyde	0.19	0.37	0.17	0.45	0.15	0.19
Temperature:						
High:	42.0		36.0		50.0	
Low:	19.0		22.0		21.0	
Mean:	27.5		29.0		41.0	
Sampling Date:	Night	2/7/85	Night	2/9/85	Day	2/9/85

	Run 4	
	Imp	Cart
Formaldehyde	2.89	2.48
Acetaldehyde	1.31	1.21
Acetone	1.61	1.50
Buteraldehyde	0.73	0.35
Temperature:		
High:	46.00	
Low:	23.00	
Mean:	33.10	
Sampling Date:	Night	2/14/85

Note: Sampling duration was 12 hours. Cartridge samples in Run 1 to Run 3 were collected without a heated probe; sample in Run 4, with heated probe. All impinger samples were collected with a heated probe.

Table 9. Effects of Storage and Transport; Reproducibility of Cartridge Sampling

Table 9a. Transport: Concentration in ppb

Sample Number	III-3	III-2	III-4	III-1	Statistics	
Date sampled	5/31/85	5/31/85	5/31/85	5/31/85		
Date Analyzed	5/31/85	6/11/85	6/11/85	6/12/85	Mean	Sigma
Formaldehyde	4.35	4.79	3.58	3.90	4.16	0.52
Acetaldehyde	2.10	2.28	2.02	2.38	2.20	0.16
Acetone	3.76	3.30	3.41	3.78	3.56	0.24
Propionaldehyde	0.20	0.25	0.22	0.32	0.24	0.05
Butyraldehyde	0.91	0.84	0.80	2.65	1.30	0.90
x-Butyraldehyde	1.05	2.82	1.33	1.06	1.56	0.84
x-Valeraldehyde	0.32	0.31	0.28	0.21	0.28	0.05

Note: Samples III-2 and III-4 were sent to and returned from the west coast by mail. Cartridges were put inside polypropylene bottle. Mailing container was unused paint can. Sample III-1 was kept in a capped polypropylene bottle in a refrigerator.

Table 9b. Storage:

Sample Number	IV-1	IV-3	IV-4		
Date sampled	6/14/85	6/14/85	6/14/85		
Date Analyzed	6/17/85	6/20/85	7/25/85		
				Mean	Sigma
Formaldehyde	4.64	3.82	4.27	4.24	0.41
Acetaldehyde	2.66	2.14	2.63	2.48	0.29
Acetone	2.95	2.57	2.84	2.79	0.20
Propionaldehyde	0.31	0.22	0.36	0.30	0.07
Butyraldehyde	4.92	2.80	1.67	3.13	1.65
x-Butyraldehyde	0.62	0.62	0.41	0.55	0.12
x-Valeraldehyde	0.10		0.27	0.18	0.12

Note: Samples IV-1 to IV-4, stored in refrigerator

Table 9c. Reproducibility:

Sample Number	III-1	III-2	III-3	III-4		
Date sampled	6/14/85	6/14/85	6/14/85	6/14/85		
Date Analyzed	6/20/85	6/20/85	6/20/85	6/20/85		
					Mean	Sigma
Formaldehyde	3.90	3.99	3.87	4.33	4.02	0.21
Acetaldehyde	2.42	2.77	2.25	2.58	2.50	0.22
Acetone	2.63	2.54	2.50	2.72	2.60	0.10
Propionaldehyde	0.26	0.35	0.27	0.31	0.30	0.04
Butyraldehyde	2.56	2.62	2.33	2.55	2.52	0.13
x-Butyraldehyde	0.85	0.90	0.79	0.92	0.86	0.06
x-Valeraldehyde	0.24	0.11	0.21	0.24	0.20	0.06

Volume of ambient air sampled = 60 - 75 L.

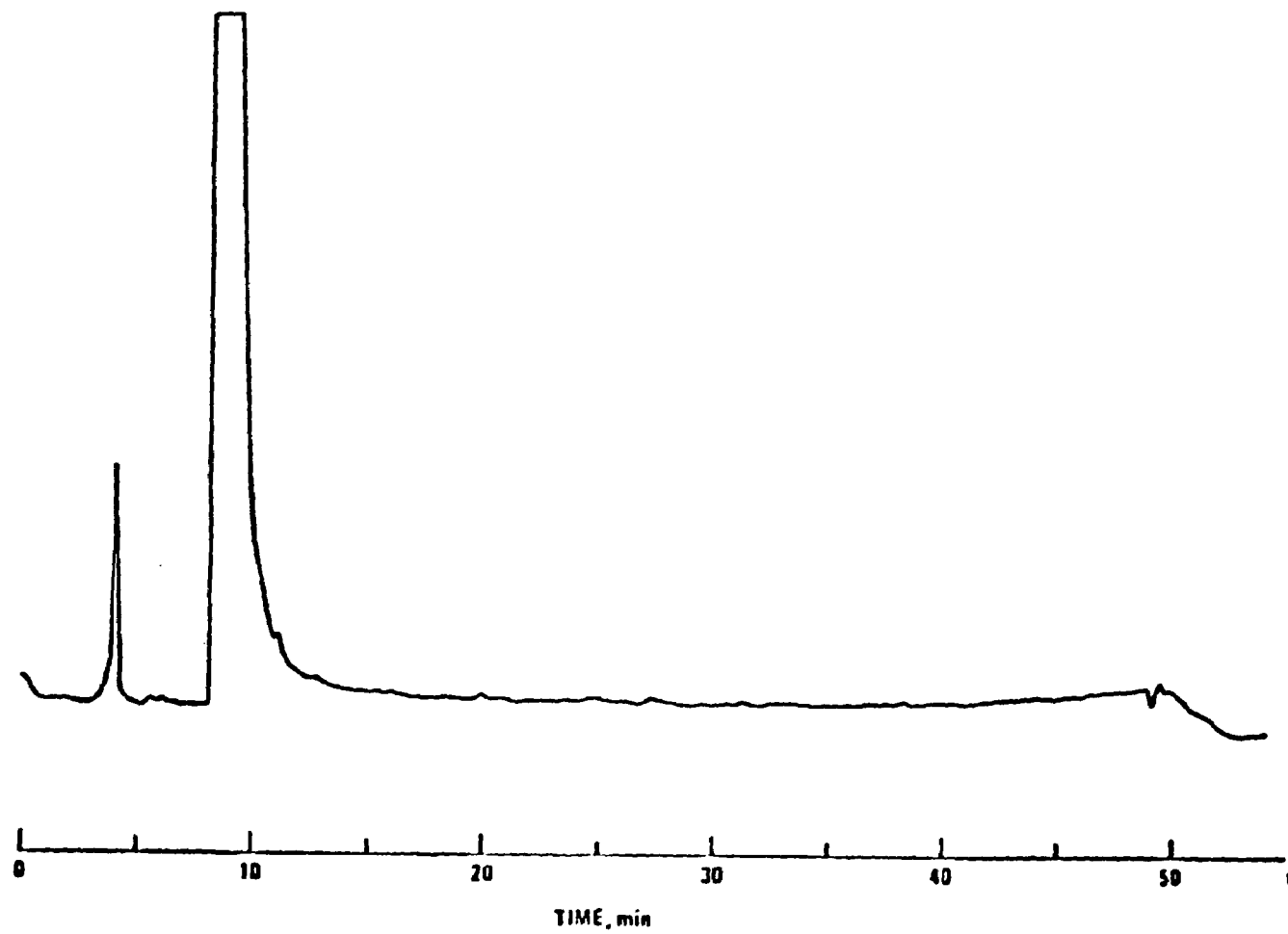
Table 10. Comparison of DNPH-Coated Silica and Florisil Cartridges for Collecting Carbonyl Compounds in Ambient Air

	Concentration in ppb			
	Run I		Run II	
	Silica	Florisil	Silica	Florisil
Formaldehyde	8.26	7.63	8.68	9.06
Acetaldehyde	1.84	0.14	2.05	0.26
Acrolein	0.14		0.15	
Acetone	4.69		8.42	
Propionaldehyde	0.24		0.26	
Crotonaldehyde	0.09		0.08	
Butyraldehyde	1.13		1.58	
Benzaldehyde	0.04		0.04	
Valeraldehyde	0.01			0.05
Hexanaldehyde	0.09		0.07	0.10
x-Propionaldehyde			0.11	0.12
x-Butyraldehyde	0.57		1.71	
x-Valeraldehyde	0.05		0.12	
x-Acrolein			0.09	

Sample volume = 108 L

Note: The silica and Florisil cartridges (both Waters Sep-PAX) were coated with the same amount of acidified DNPH per procedures described in this report. Florisil cartridge in Run 2 was new (never used) before it was coated. In Run 1, the Florisil cartridge was reclaimed (previously coated and used for carbonyl sampling). The silica cartridges were likewise reclaimed.

Figure 1



C-44

Figure
(2)

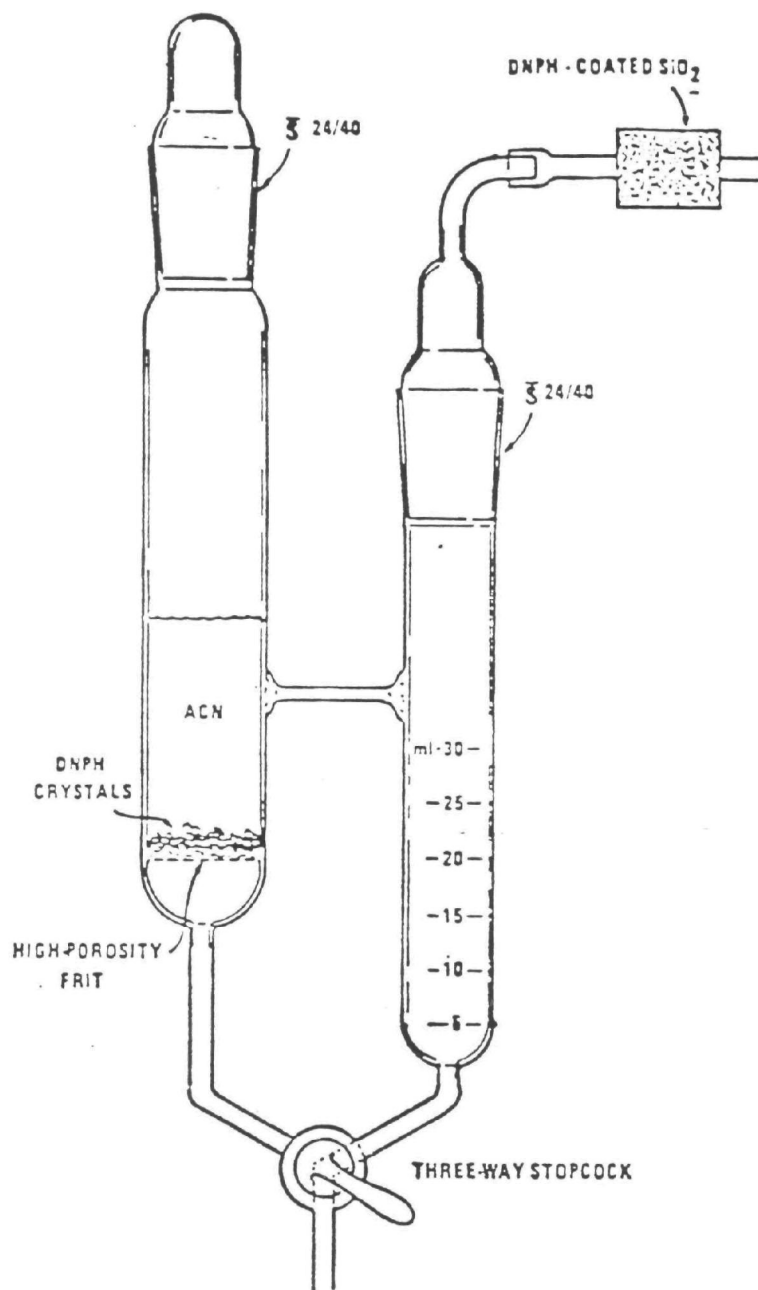


Figure 3

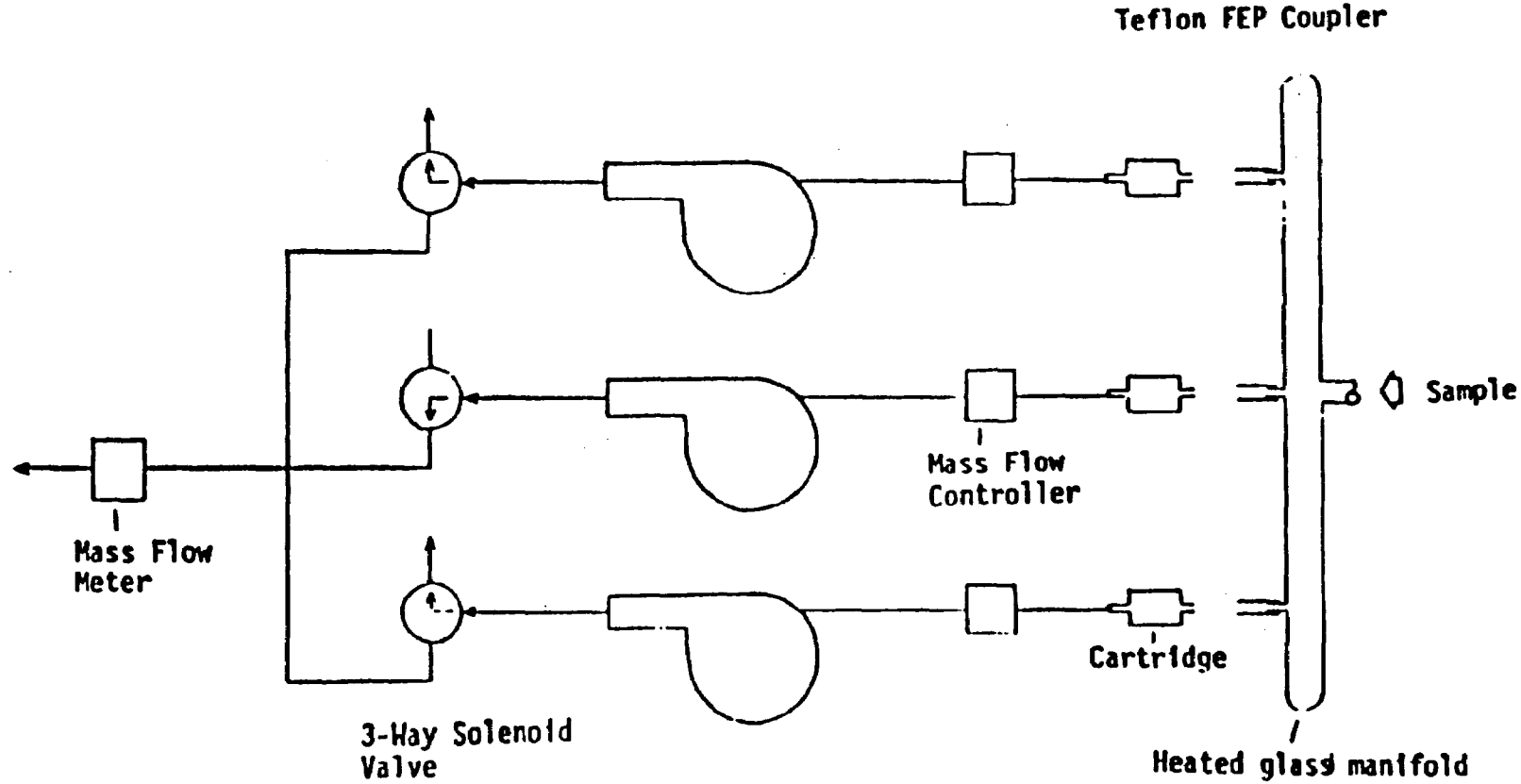


Figure 4

C-47

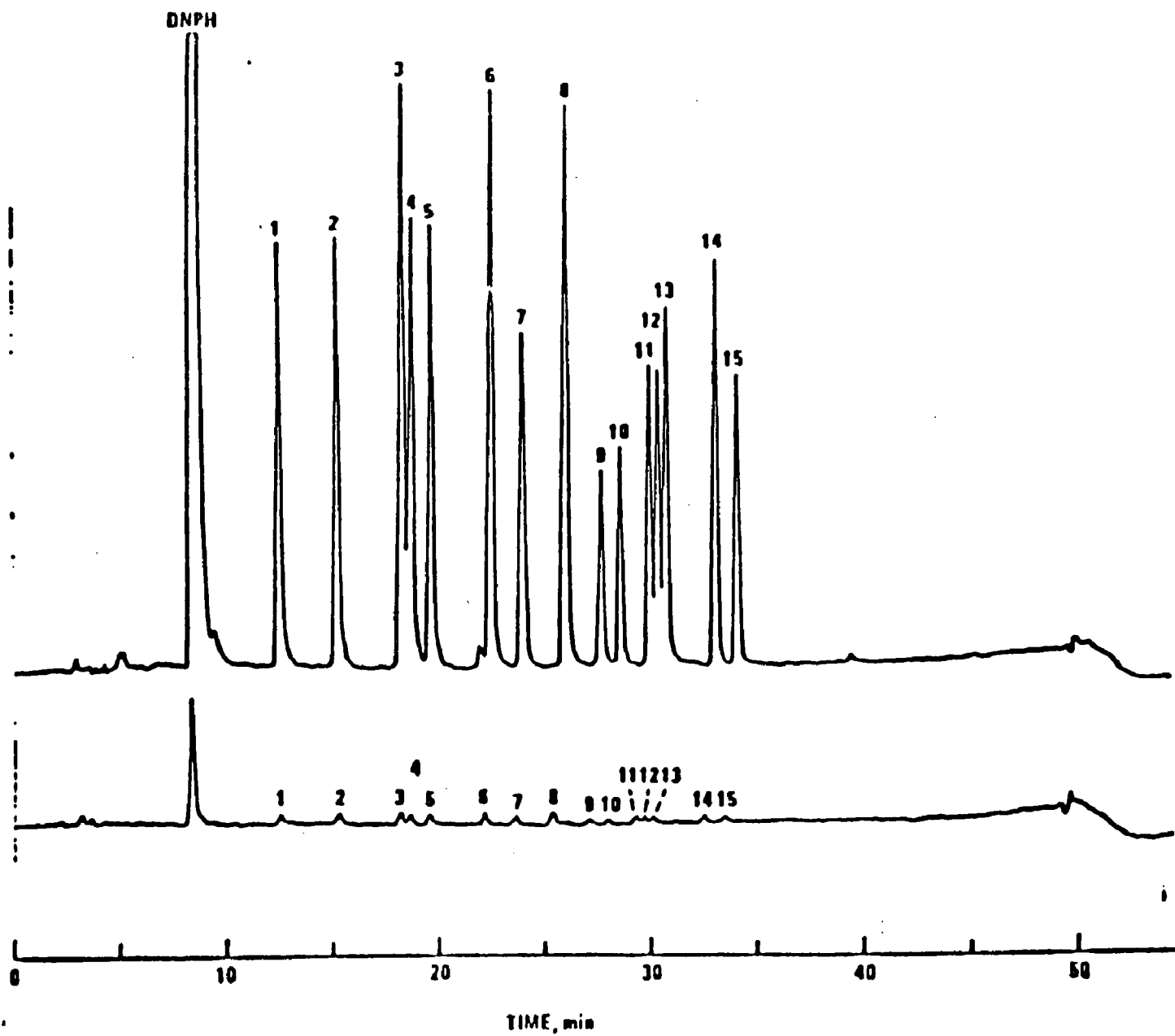
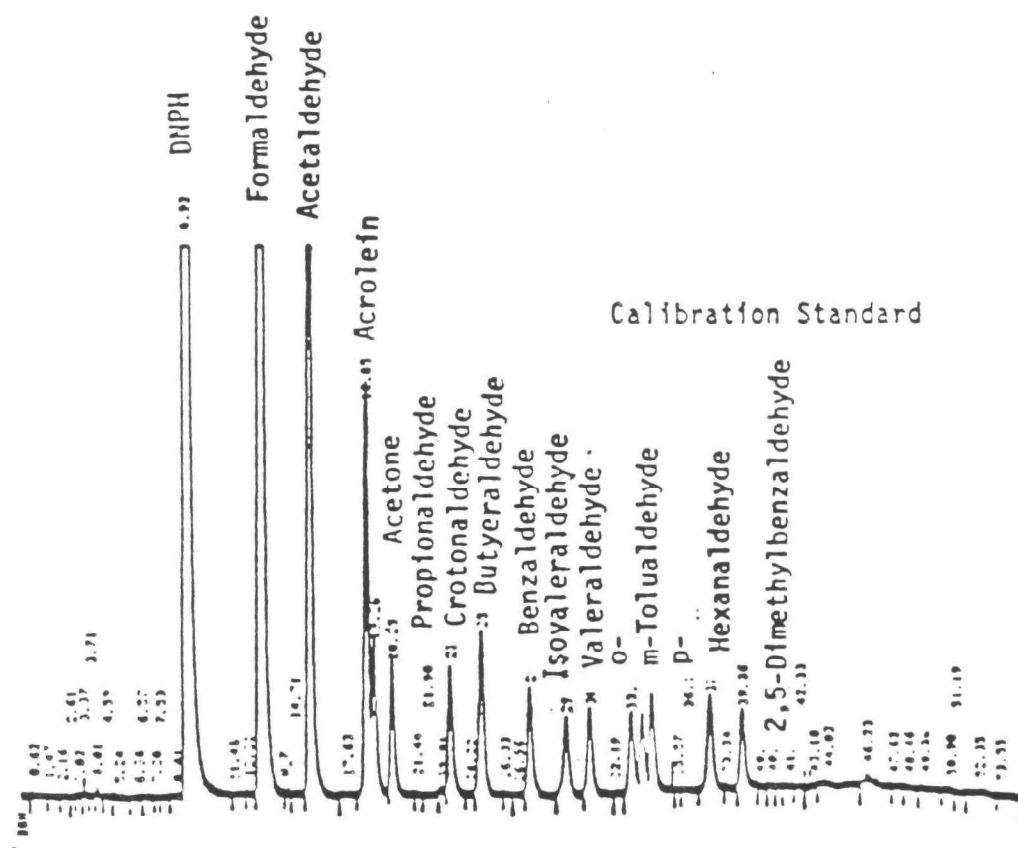


Figure 5



STABILITY OF ACROLEIN DNPH DERIVATIVE IN ABSORBING SOLUTION

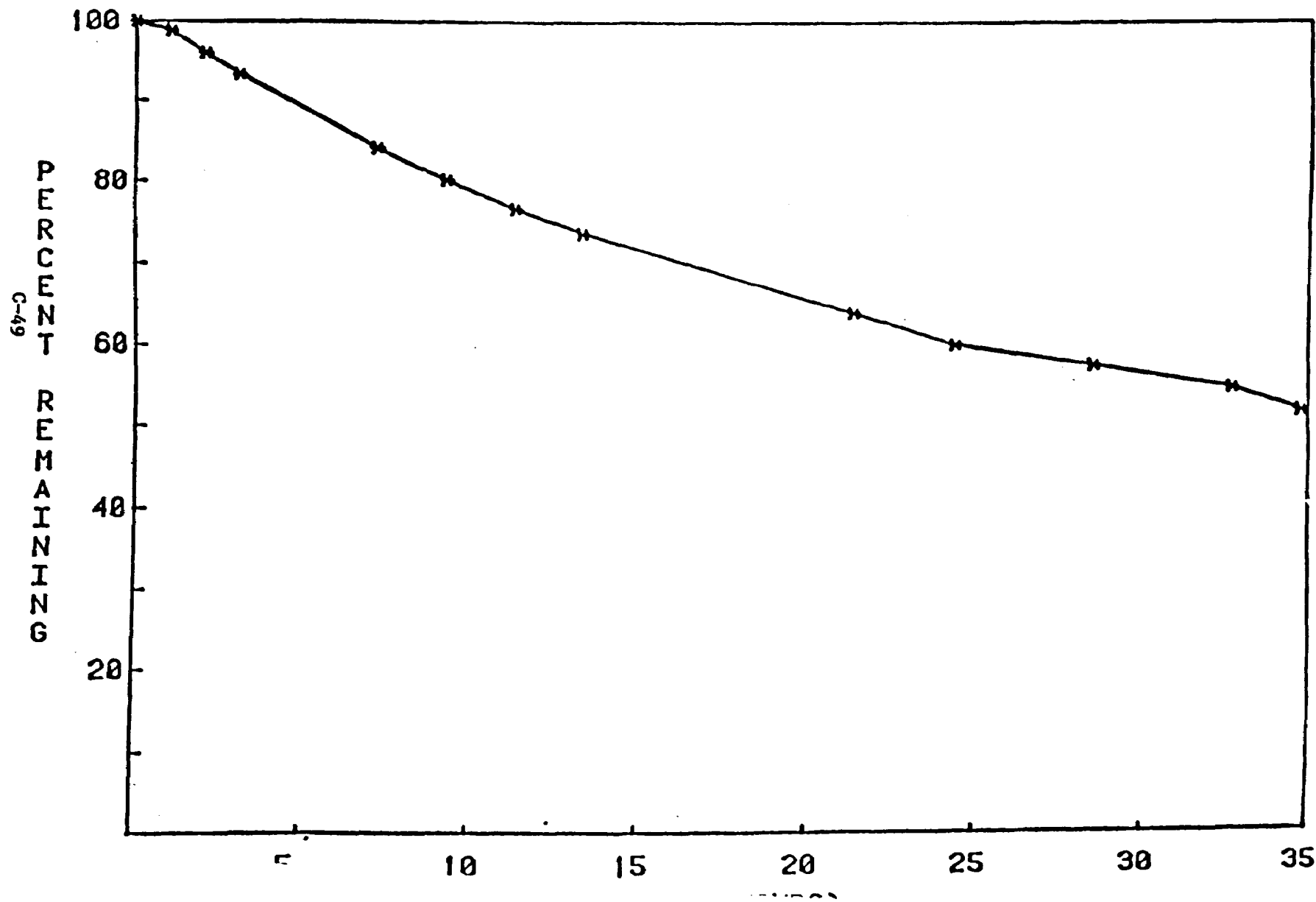


Figure 1

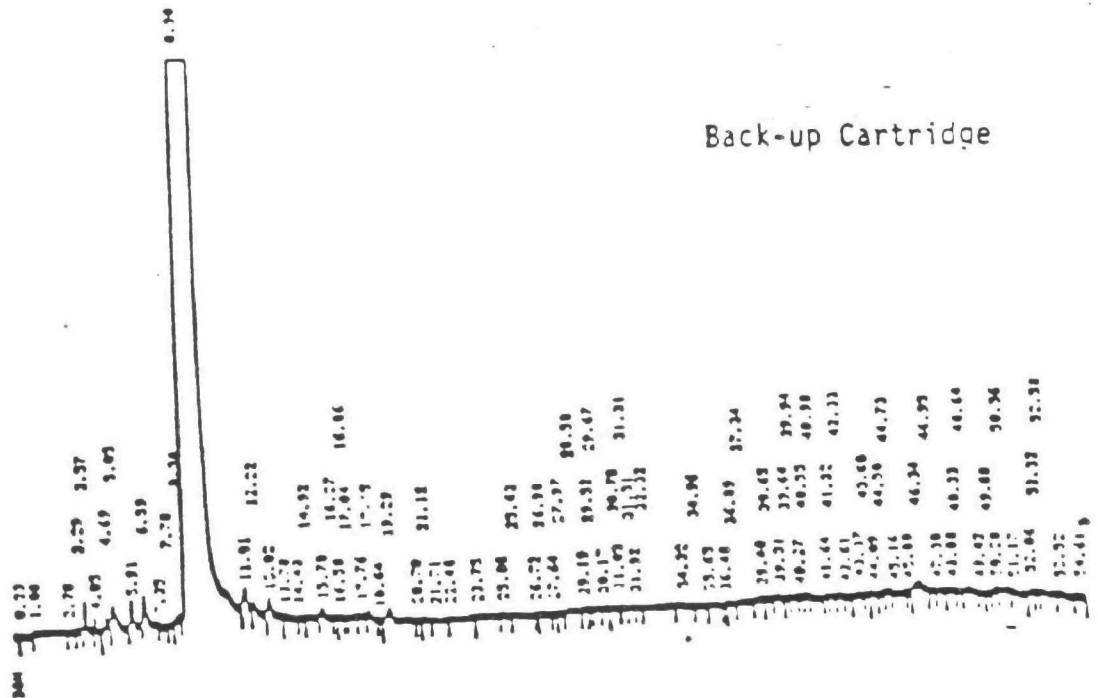
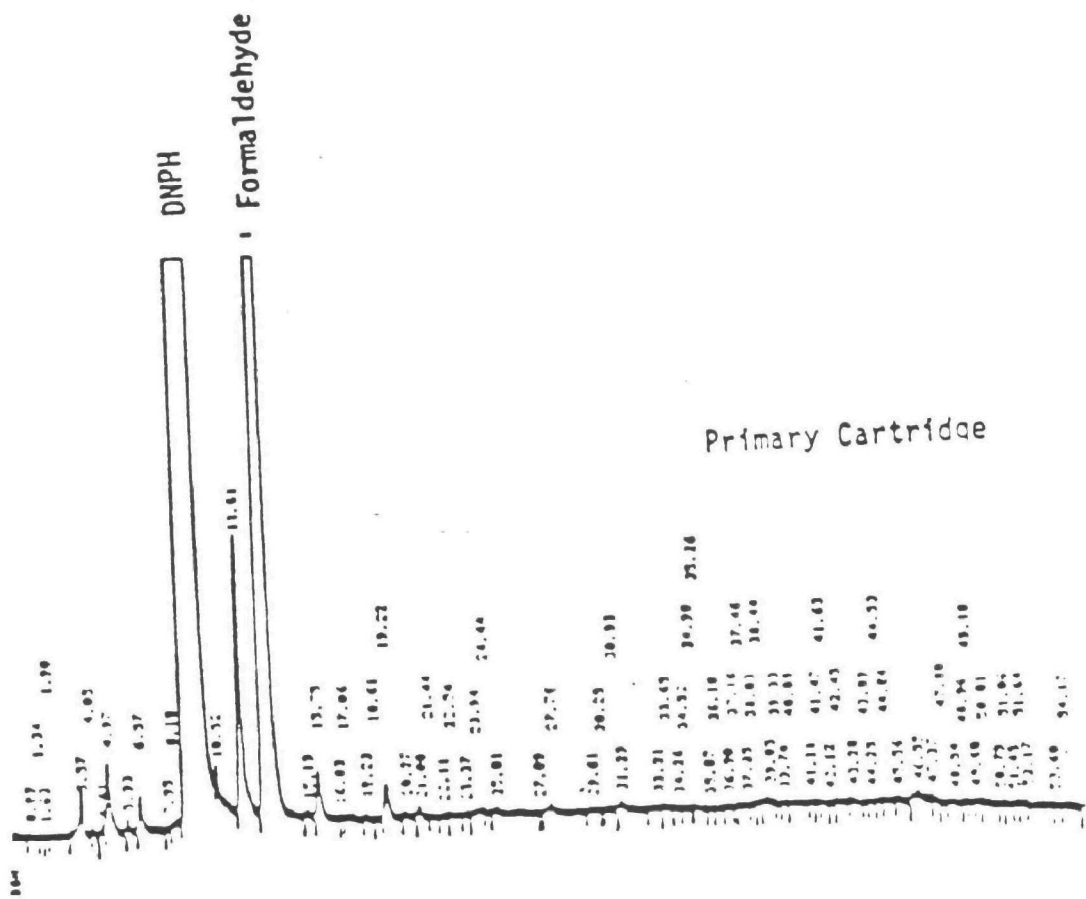
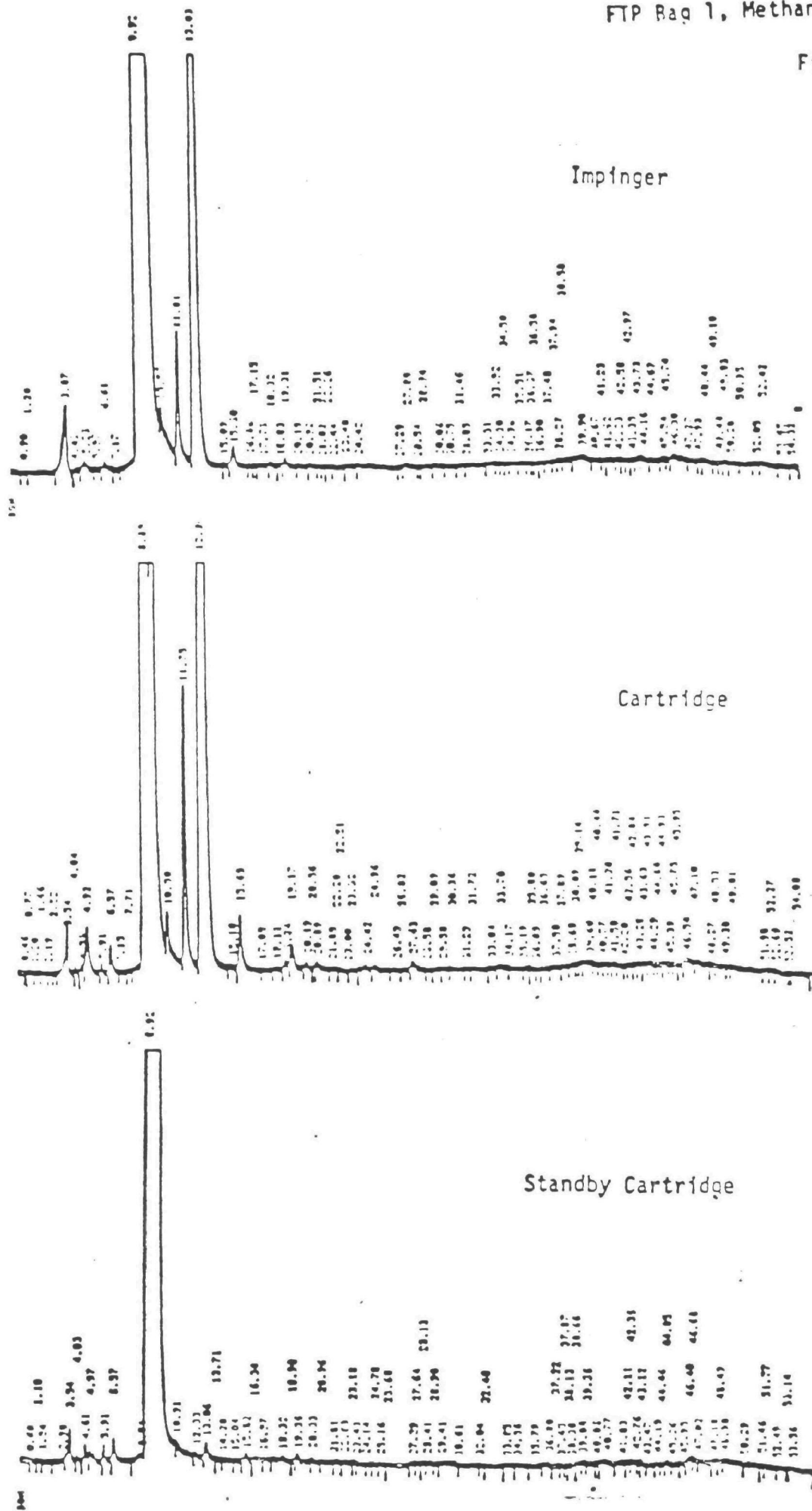
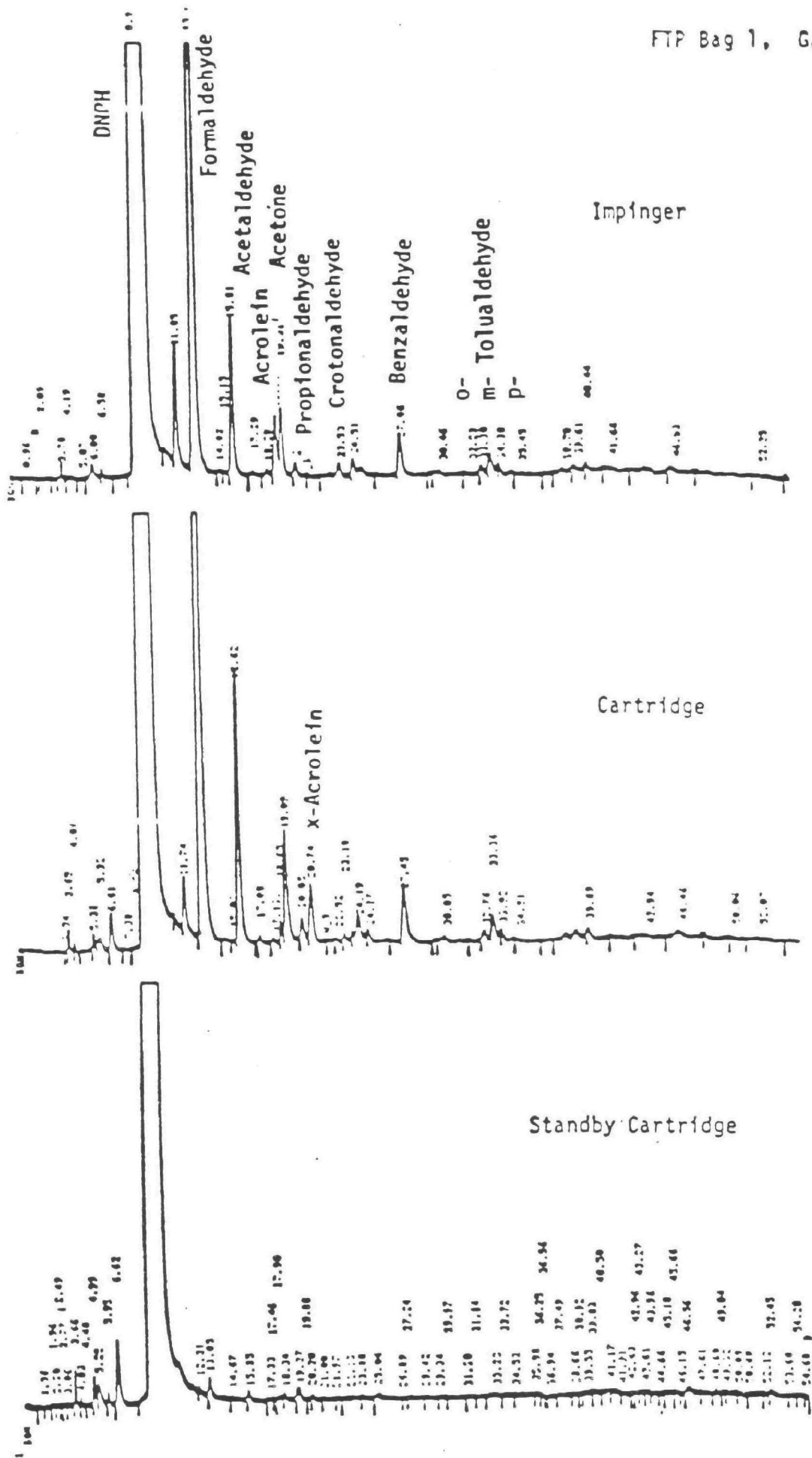


Figure 8





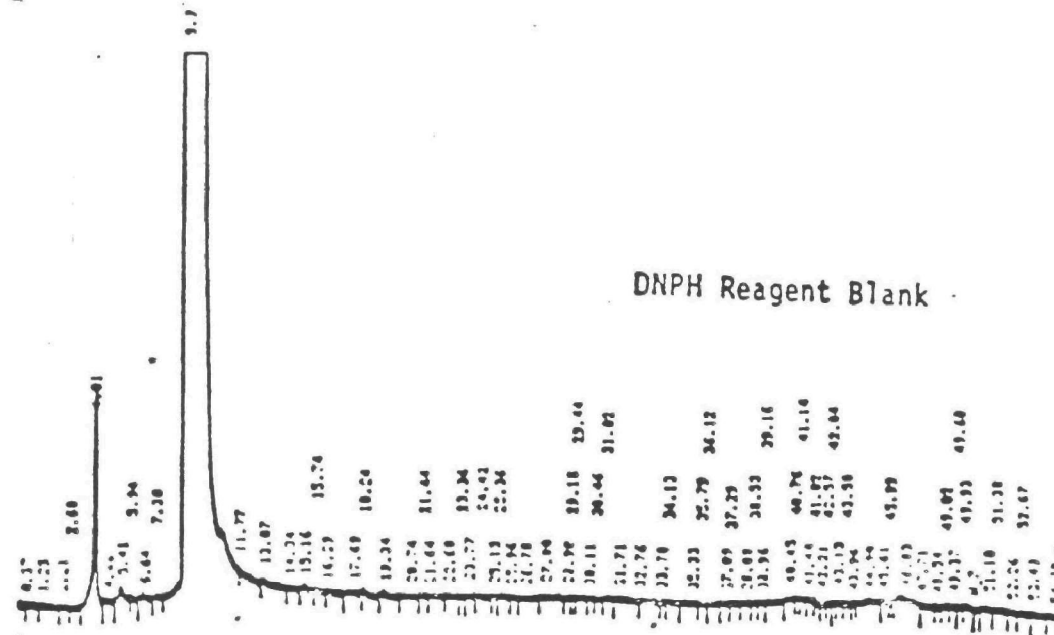
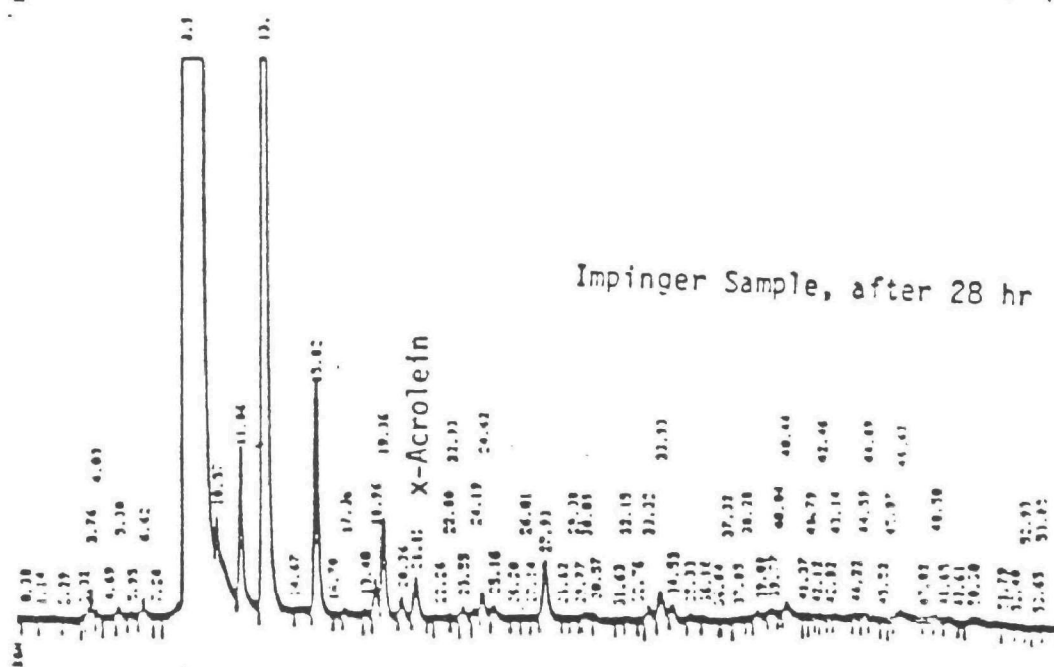
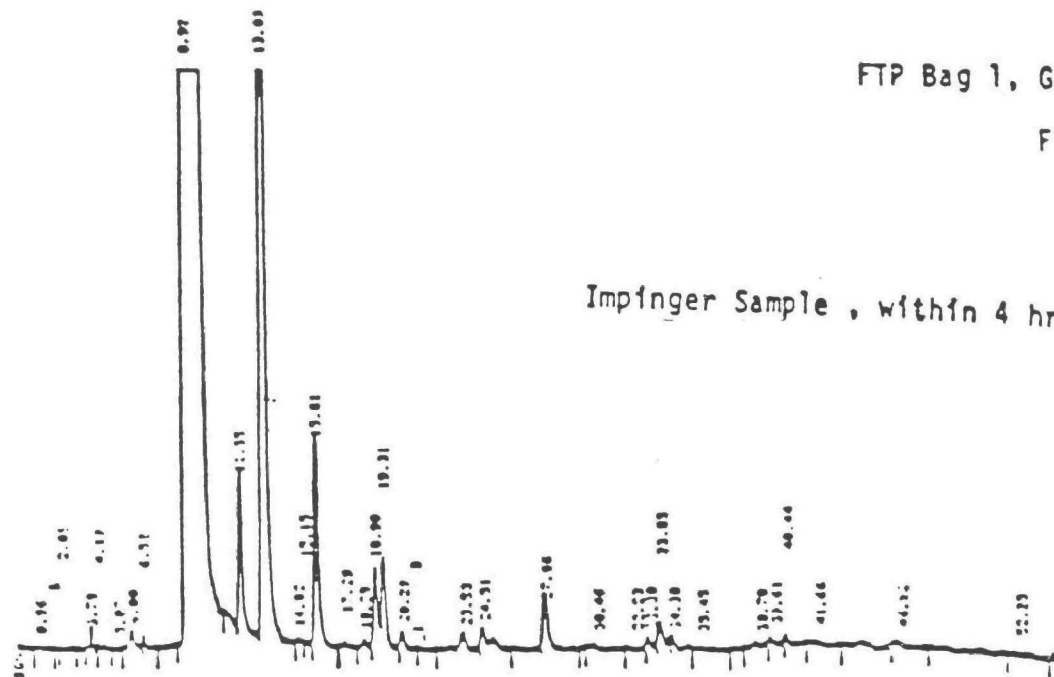
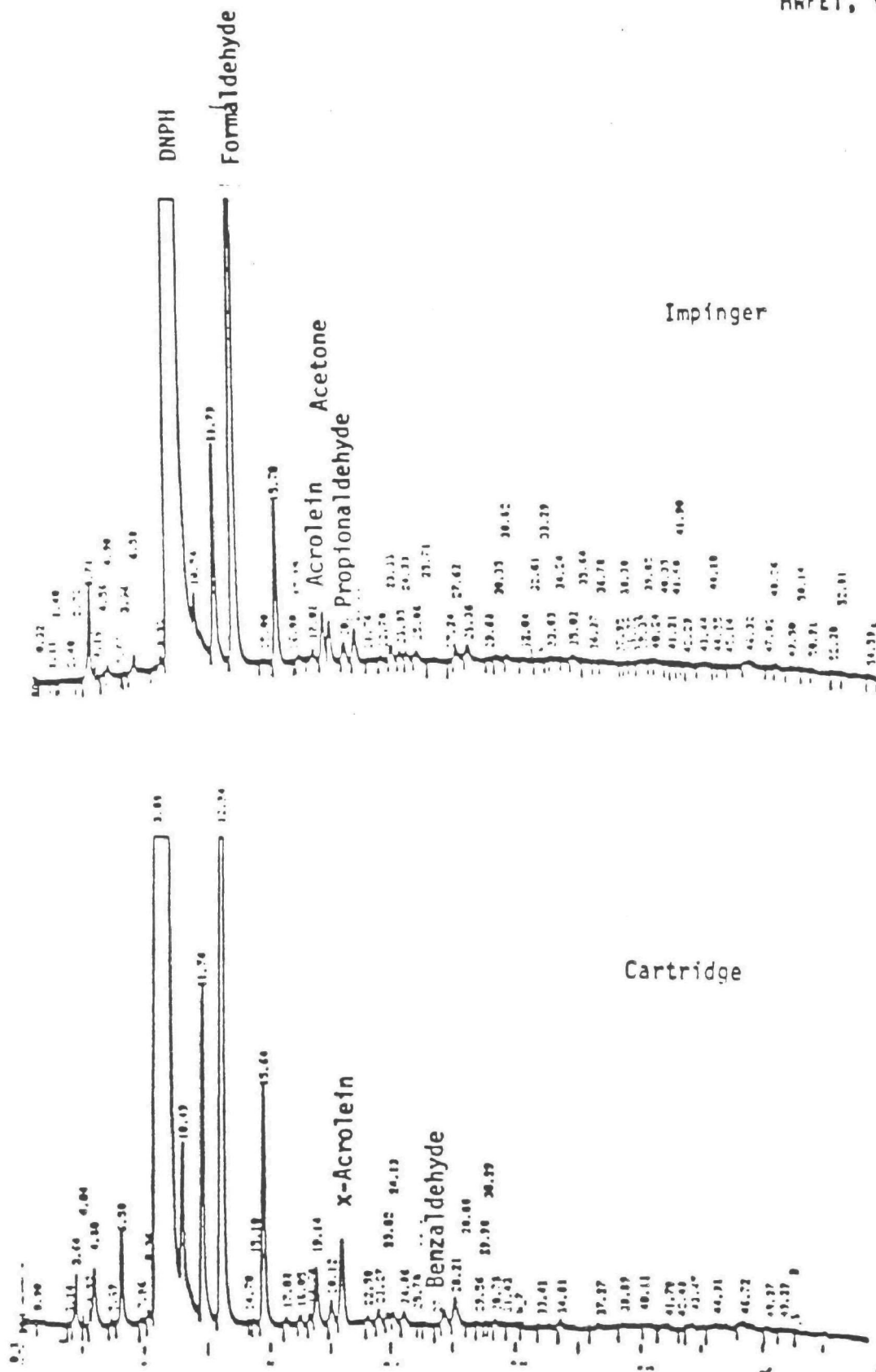


Figure 11



Flaure 12



Fig. 13

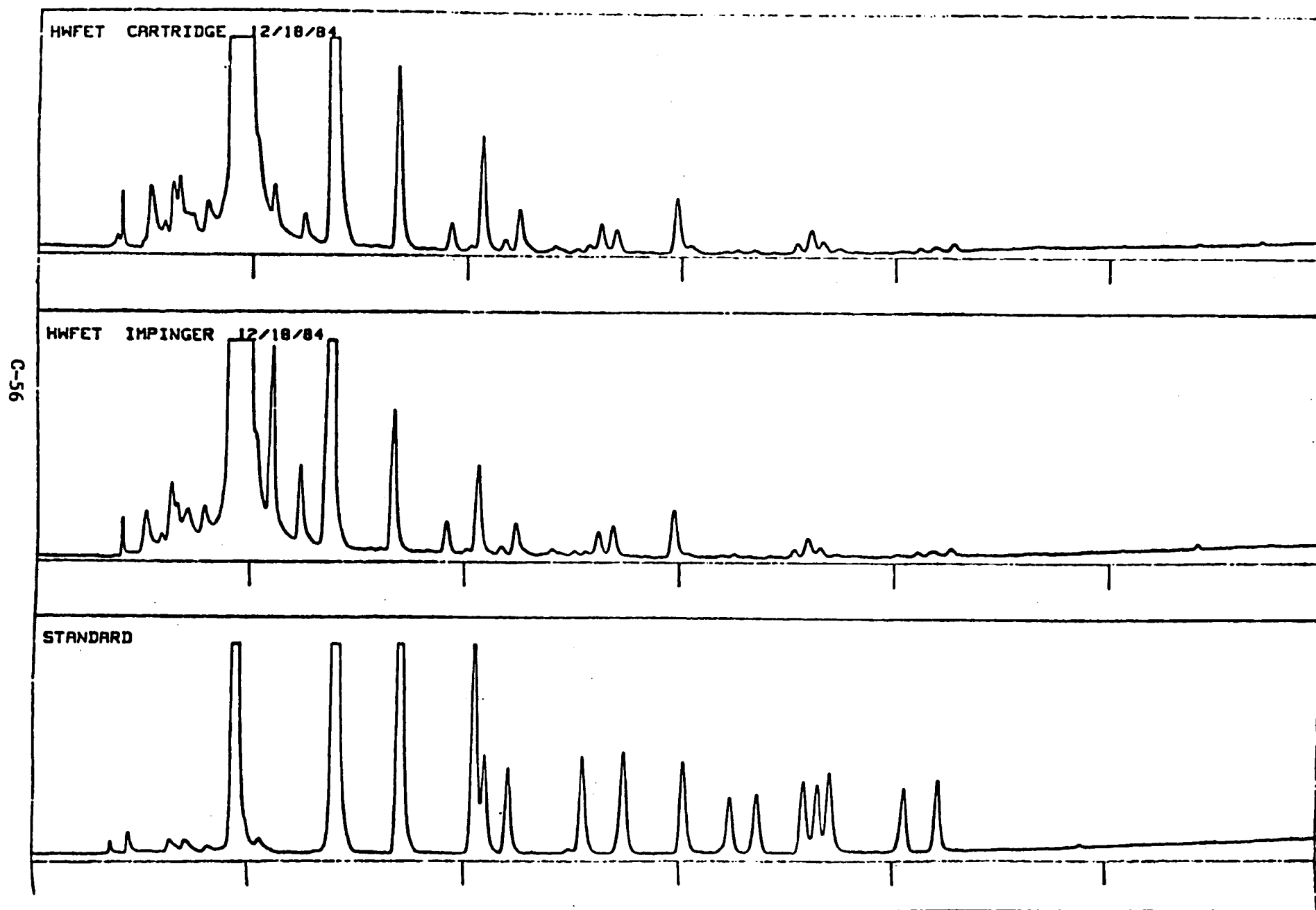


Fig. 124

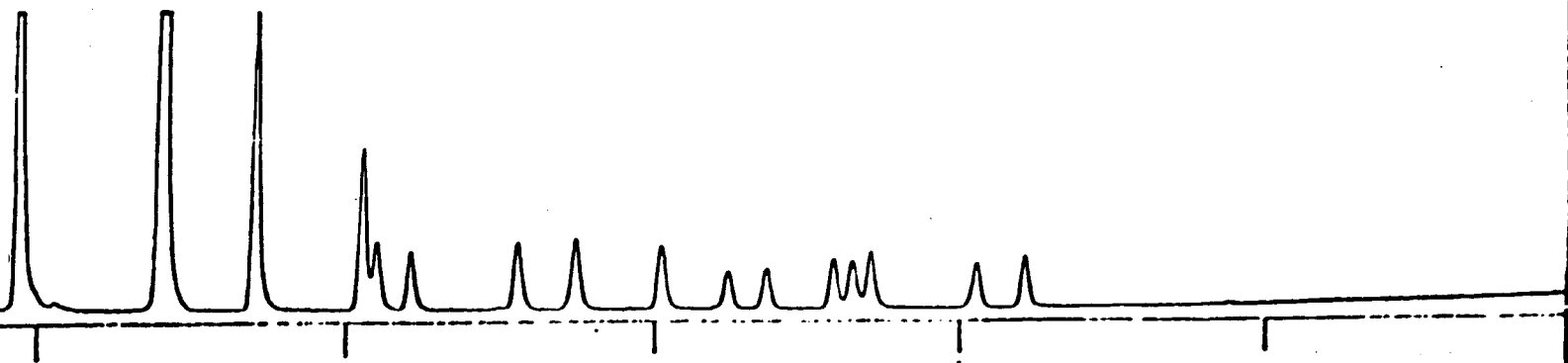
PRIMARY - CARTRIDGE 021085 VOLUME - 622.8 LITERS



PRIMARY - IMPINGER 020985 VOLUME - 360 LITERS

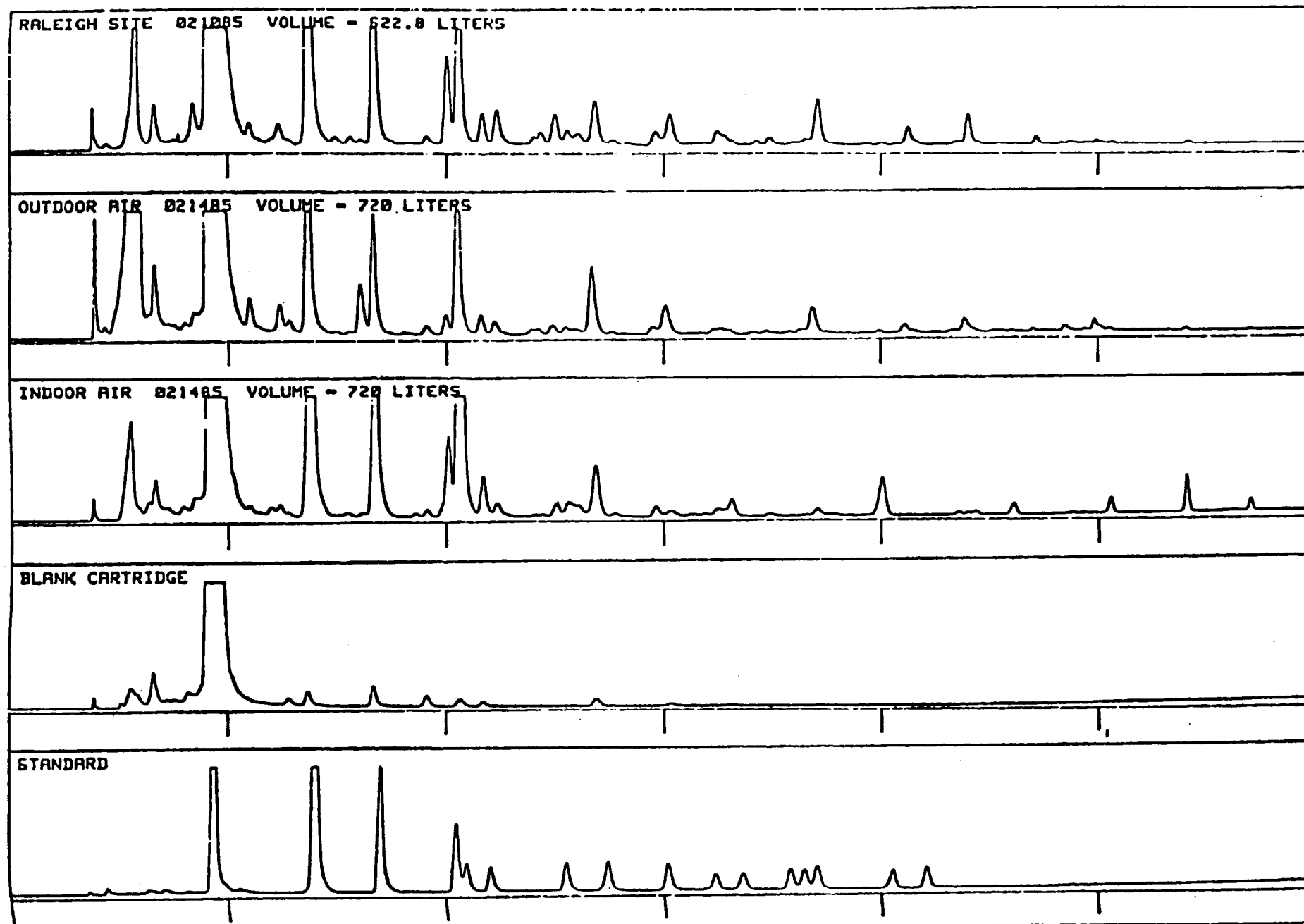


STANDARD

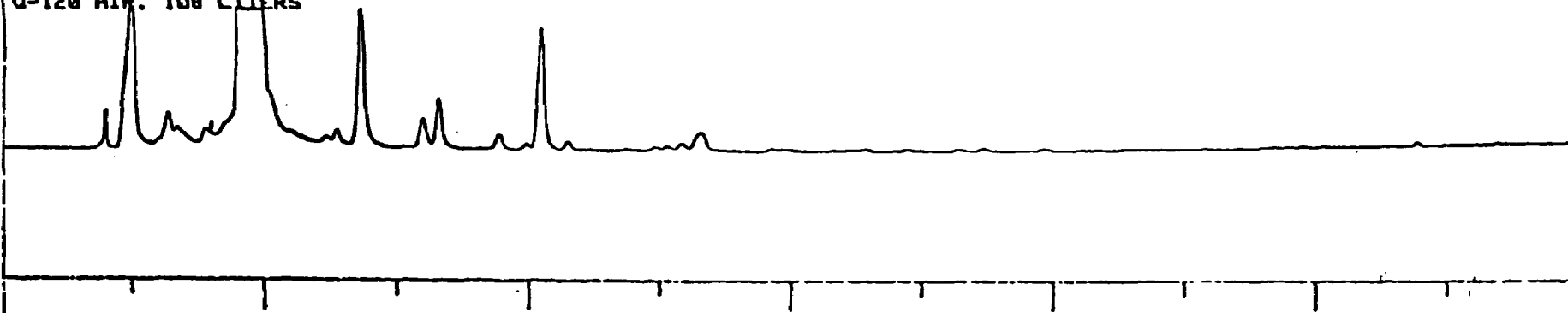


C-57

C-58

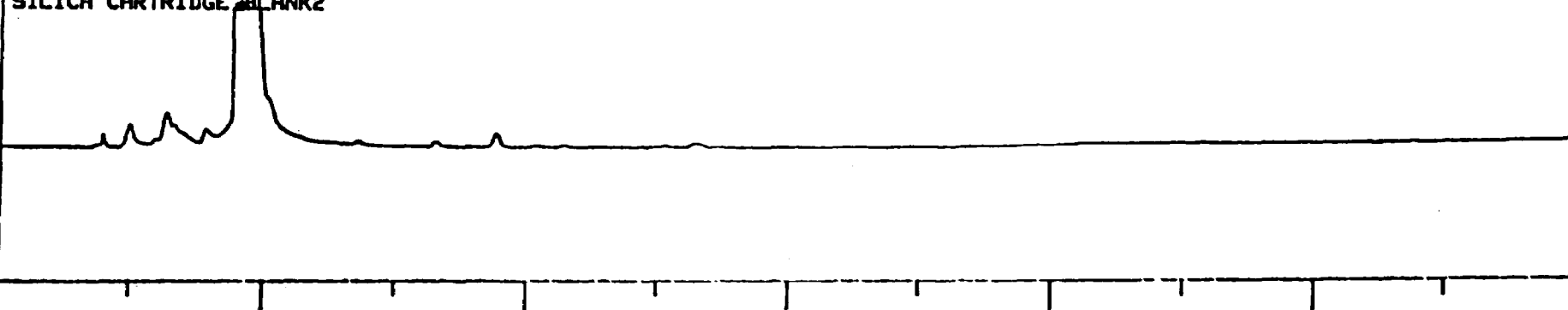


Q-120 AIR. 100 LITERS



SILICA CARTRIDGE BLANK2

C-59



SILICA CARTRIDGE BLANK

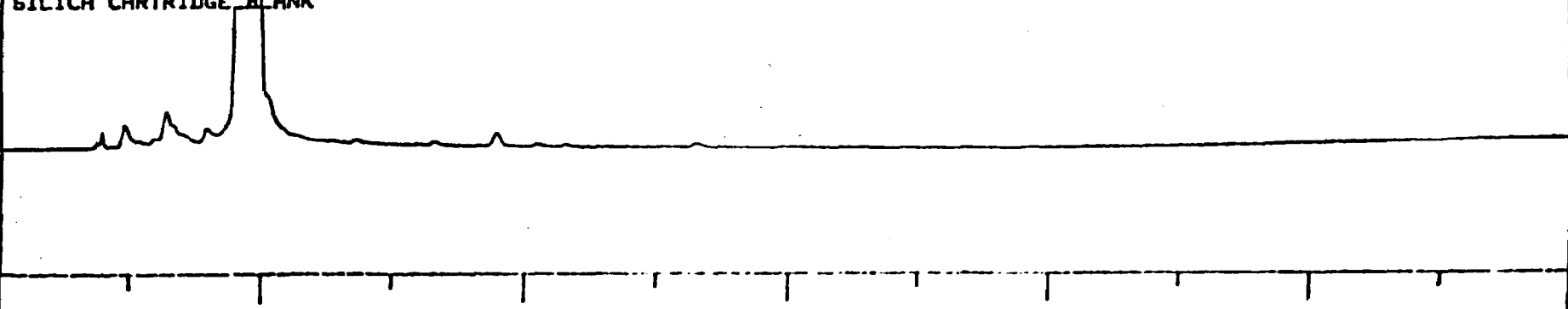
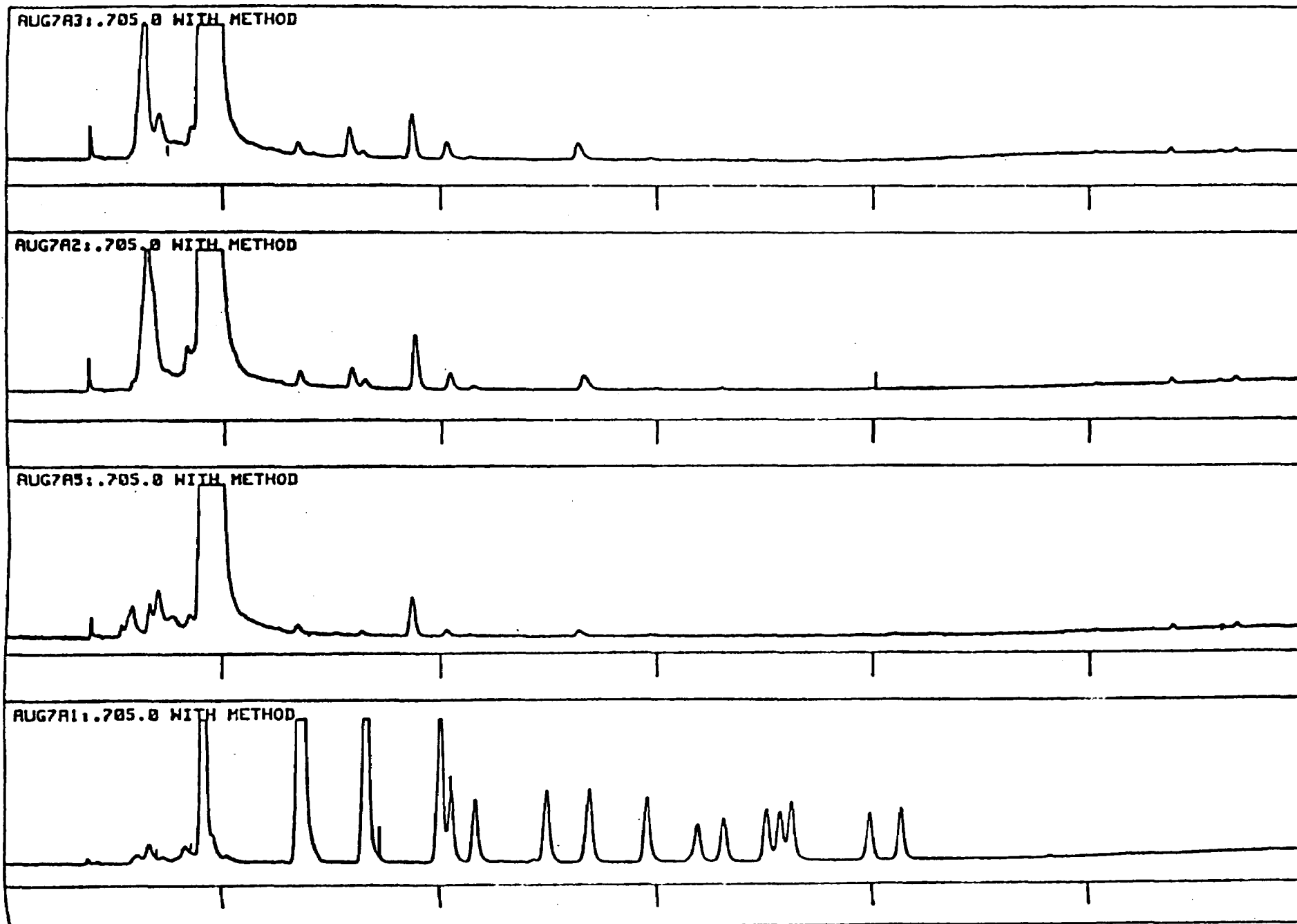
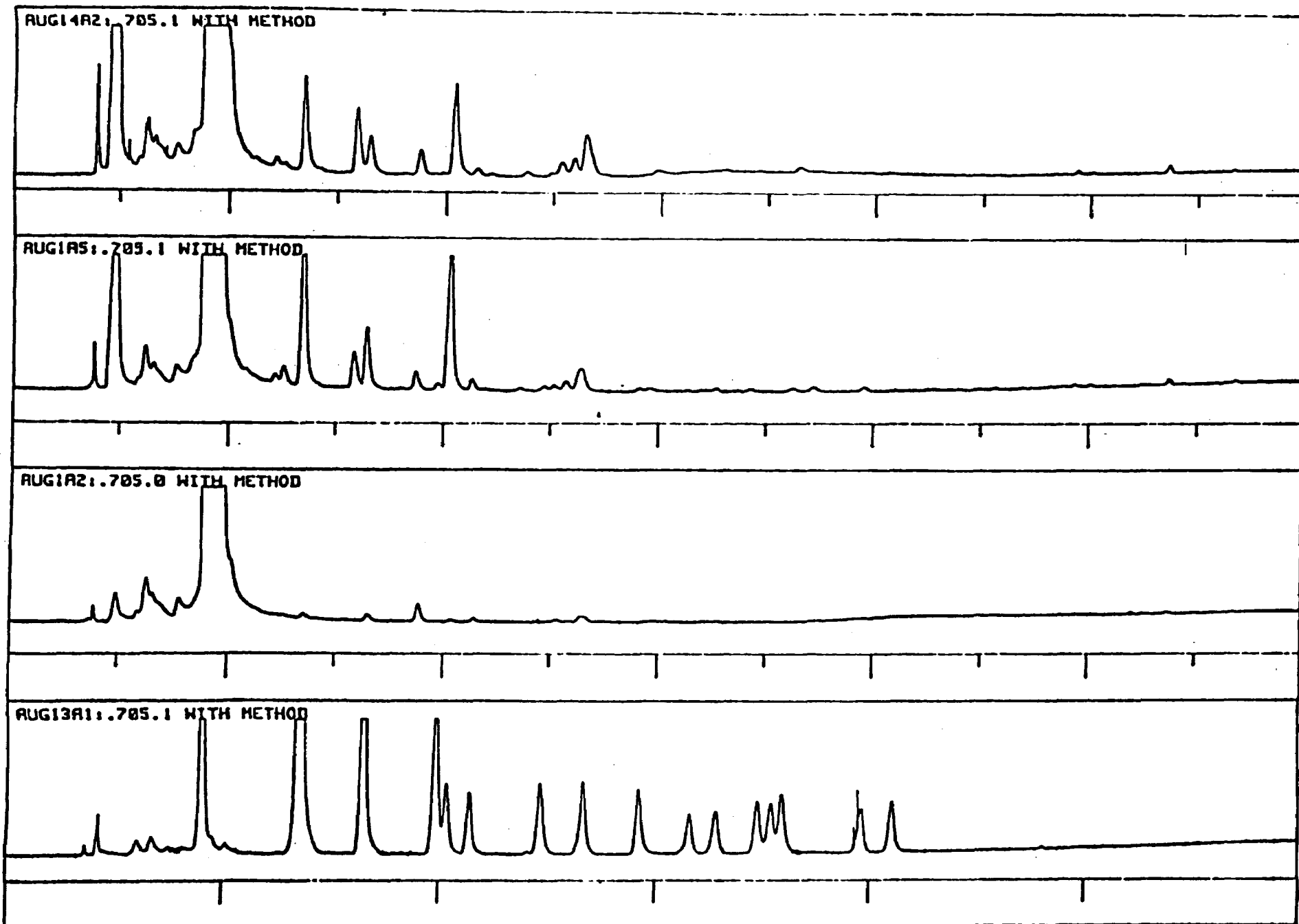


Fig. 17

C-60



19-2



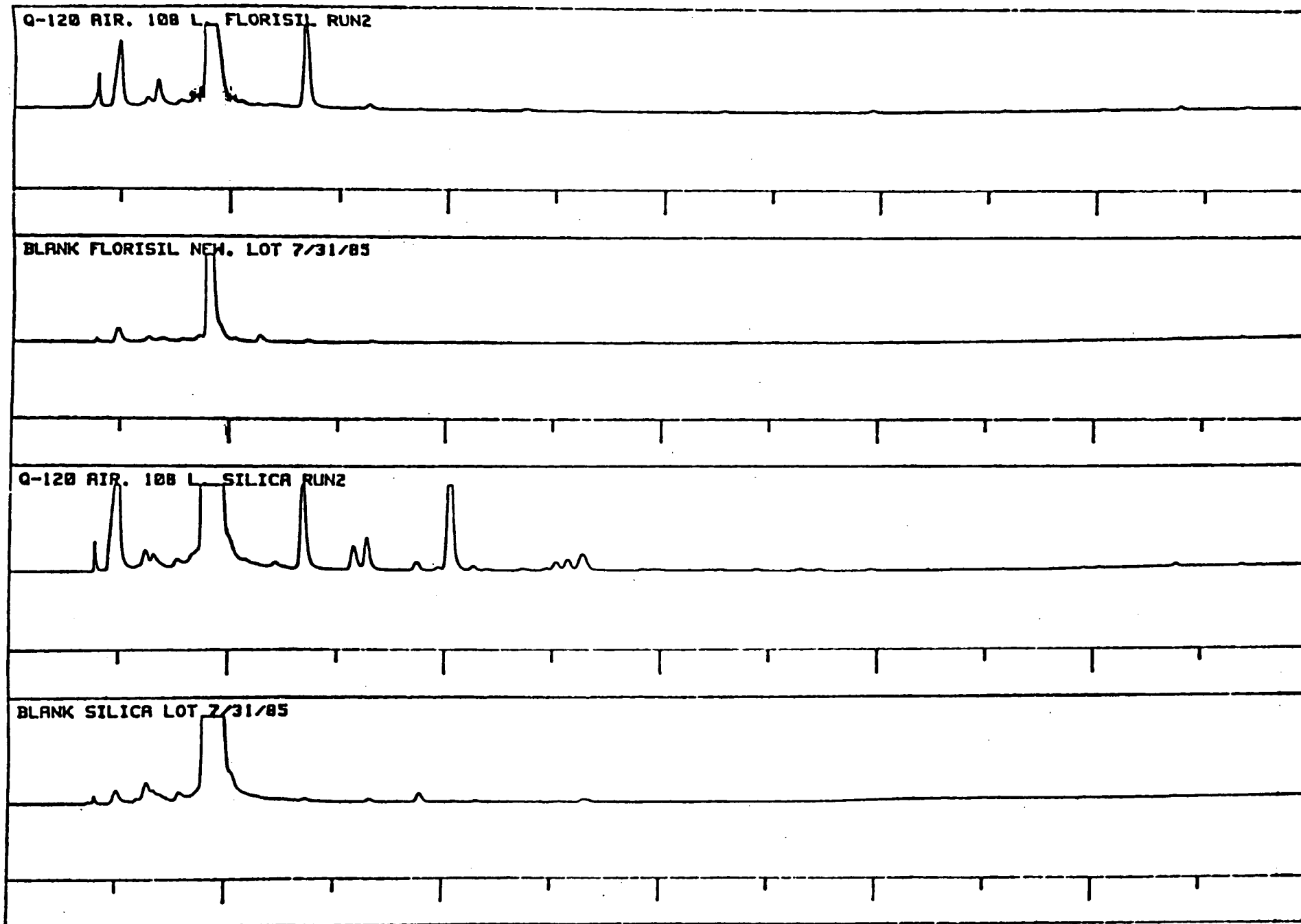
Q-120 AIR. 100 L. FLORISIL RUN1

BLANK FLORISIL USED. LOT 7/31/85

Q-120 AIR. 100 L. SILICA RUN1

BLANK SILICA LOT 2/31/85

C-63



SENSITIVITY (PPB, V/V) OF DNPH/HPLC METHOD
FOR CARBONYLS IN AIR

VOLUME OF SAMPLE, LITERS	10	20	30	40	50	60
Formaldehyde	1.45	0.73	0.48	0.36	0.29	0.24
Acetaldehyde	1.36	0.68	0.45	0.34	0.27	0.23
Acrolein	1.29	0.65	0.43	0.32	0.26	0.22
Acetone	1.28	0.64	0.43	0.32	0.26	0.21
Propionaldehyde	1.28	0.64	0.43	0.32	0.26	0.21
Crotonaldehyde	1.22	0.61	0.41	0.31	0.24	0.20
Butyraldehyde	1.21	0.61	0.40	0.30	0.24	0.20
Benzaldehyde	1.07	0.53	0.36	0.27	0.21	0.18
Isovaleraldehyde	1.15	0.57	0.38	0.29	0.23	0.19
Valeraldehyde	1.15	0.57	0.38	0.29	0.23	0.19
o-Tolualdehyde	1.02	0.51	0.34	0.25	0.20	0.17
m-Tolualdehyde	1.02	0.51	0.34	0.25	0.20	0.17
p-Tolualdehyde	1.02	0.51	0.34	0.25	0.20	0.17
Hexanaldehyde	1.09	0.55	0.36	0.27	0.22	0.18
2,5-Dimethylbenzaldehyde	0.97	0.49	0.32	0.24	0.19	0.16

VOLUME OF SAMPLE, LITERS	100	200	300	400	500	1000
Formaldehyde	0.15	0.07	0.05	0.04	0.03	0.01
Acetaldehyde	0.14	0.07	0.05	0.03	0.03	0.01
Acrolein	0.13	0.06	0.04	0.03	0.03	0.01
Acetone	0.13	0.06	0.04	0.03	0.03	0.01
Propionaldehyde	0.13	0.06	0.04	0.03	0.03	0.01
Crotonaldehyde	0.12	0.06	0.04	0.03	0.02	0.01
Butyraldehyde	0.12	0.06	0.04	0.03	0.02	0.01
Benzaldehyde	0.11	0.05	0.04	0.03	0.02	0.01
Isovaleraldehyde	0.11	0.06	0.04	0.03	0.02	0.01
Valeraldehyde	0.11	0.06	0.04	0.03	0.02	0.01
o-Tolualdehyde	0.10	0.05	0.03	0.03	0.02	0.01
m-Tolualdehyde	0.10	0.05	0.03	0.03	0.02	0.01
p-Tolualdehyde	0.10	0.05	0.03	0.03	0.02	0.01
Hexanaldehyde	0.11	0.05	0.04	0.03	0.02	0.01
2,5-Dimethylbenzaldehyde	0.10	0.05	0.03	0.02	0.02	0.01

NOTE: PPB VALUES MEASURED AT 1 ATM. AND 25 DEGREES CELSIUS
SAMPLE CARTRIDGE IS ELUTED WITH 5 ML ACETONITRILE
25 MICROLITERS INJECTED ONTO HPLC COLUMN

MAXIMUM SAMPLING FLOW THROUGH A DNPH-COATED SEP-PAK
IS ABOUT 1.5 LITERS PER MINUTE

APPENDIX D

WEATHER DATA
P.S 26 - STATEN ISLAND

Wind Direction-Frequency (%)

Date Sampled		N	NE	E	SE	S	SW	W	NW	AVE WIND SPEED (MPH)	AVE TEMP(F)
7/10/90	AM PM						33	67 83	17	7.3 6.5	81.1 82.2
7/22/90	AM PM		50	17	50 83					2.6 3.6	76.3 74.8
8/3/90	AM PM									- -	- -
8/15/90	AM PM	17	17				33	8 42	58 25	5.0 1.7	77.0 74.0
8/27/90	AM PM	17	17			33 8	8	42	33 42	4.2 1.7	81.0 76.0
9/8/90	AM PM	50 8	34 8	8 25	8 42				17	8.8 2.3	61.8 59.8
9/20/90	AM PM	33						42 8	58 59	- -	- -
10/2/90	AM PM	25				8	33 8	25 25	42 34	9.9 3.7	61.6 56.2
10/14/90	AM PM	8		8	8	50	17	8 17	84	4.5 2.1	73.1 68.7
10/26/90	AM PM	100 17							83	17.4 14.2	48.6 42.2
11/7/90	AM PM						25 8	42 67	33 25	3.7 5.3	45.6 46.9
11/19/90	AM PM	33						100	67	9.5 7.2	37.0 38.9
12/1/90	AM PM					33	67 100			6.5 4.3	40.7 43.7
12/13/90	AM PM					8	50	42 17	83	6.7 13.0	48.0 45.1
12/25/90	AM PM	42				75	25 50		8	4.6 5.4	27.4 27.7
1/6/91	AM PM	9 67		8			33	33	25 25	2.7 4.0	39.0 38.4
1/18/91	AM PM						33 17	67 75	8	13.0 10.7	36.7 37.3

Wind Direction-Frequency (%)

Date Sampled		N	NE	E	SE	S	SW	W	NW	AVE WIND SPEED (MPH)	AVE TEMP(F)
1/30/91	AM			25	17	8	42		8	1.1	38.6
	PM			8	33	18	8	25	8	2.9	46.5
2/11/91	AM							25	75	8.5	32.6
	PM							8	92	12.1	27.9
2/23/91	AM	67							33	12.1	27.2
	PM	33	25	17	8	17				0.6	28.5
3/7/91	AM						33	67		13.5	48.5
	PM							58	42	14.7	34.7
3/19/91	AM							17	83	14.0	46.1
	PM								100	13.5	47.8
TOTALS											
	AM	13	6	2	4	4	20	22	29	-	-
	PM	11	2	4	8	5	12	22	36	-	-
	24 Hour	17	3	3	6	3	15	22	31	-	-

Note: Weather data unavailable for sample date 8/3/90.

#11720645

APPENDIX D

Climatronic Calibration Procedure

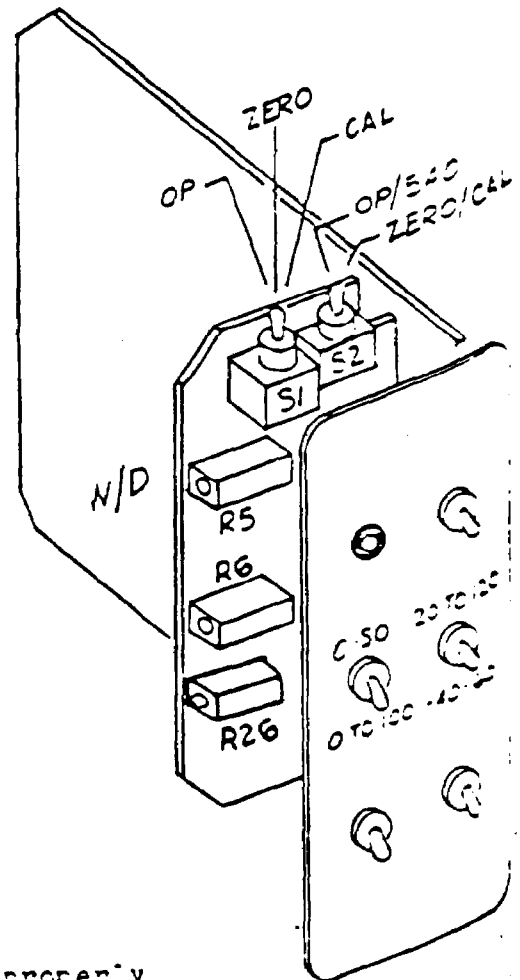


CALIBRATION PROCEDURE

ENGLISH

2. Wind Direction

- a. Place S1 in "Zero" position.
Place S2 in "Zero/Cal" position.
- b. Adjust R26 for 0° indication.
- c. Adjust the recorder mechanical zero for a 0° reading.
- d. Place S1 in "Cal." position.
Place S2 in "Zero/Cal." position.
- e. Adjust R5 for 350° reading.
- f. Place S1 in "Zero" position.
Place S2 in "Op/540" position.
- g. Adjust R6 for 360° reading.
- h. Place S1 in "Op" position.
Place S2 in "Op/540" position.
- i. Rotate vane slightly to check for meter deflection.

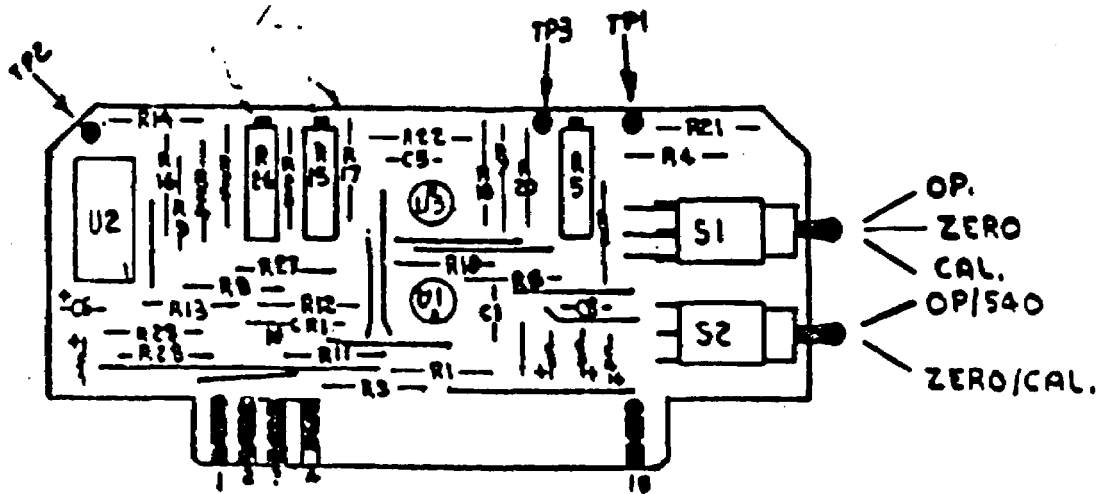


NOTE: Make sure the WS/WD sensor is properly connected before attempting to calibrate the board.

Climatronics EWS

Electronic Calibration

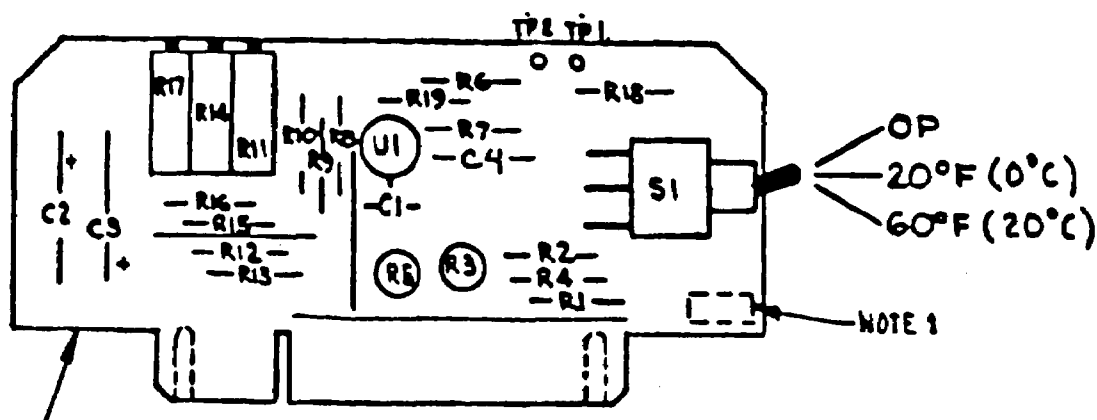
(5) Wind Direction Signal Conditioner



- a. Set switch S1 in "ZERO" and S2 in "ZERO CAL".
- b. Adjust R26 for zero (0.00 volts) at TP 3.
- c. Adjust the recorder mechanical zero for a proper zero indication on the chart.
- d. Set switch S1 in "CAL", S2 in "ZERO CAL".
- e. Adjust R5 for 0.648 volts at TP 3, a reading of 350° on the chart.
- f. Set switch S1 in "ZERO", S2 in "OP/540".
- g. Adjust R15 for 0.667 volts at TP 3, a reading of 360° on the chart.

- D-6

Temperature.



- (a) Place S1 in the 20°F (0°C) position.
- (b) Place the front panel range switch in the 20° to 120°F (0° to 50°C) position.
- (c) Adjust R17 for a 0% reading on the chart relative humidity scale (20°F or 0°C).
(0.00V at TP 2.)
- (d) Place S1 in the 60°F (20°C) position.
- (e) Adjust R11 for a 40% reading on the chart relative humidity scale (60°F or 20°C).
(0.40V at TP 2.)
- (f) Change the front panel range switch to the -40° to 60°F (-30° to 20°C) position.
- (g) Adjust R14 for a 100% reading on the chart relative humidity scale (60°F or 20°C).
(1.00V at TP 2.)

APPENDIX E
QUALITY ASSURANCE DISCUSSION FOR THE VOCS

INTRODUCTION

The New York State Department of Health (DOH) participated in the Staten Island/New Jersey Urban Air Toxics Assessment Project (SI/NJ UATAP) to characterize the concentration of several organic compounds found in ambient and indoor air. Indoor air contaminant levels were determined in four homes, concurrently with sampling of contaminant levels at nearby ambient monitoring stations. The indoor locations selected were two residences in Staten Island, New York, and two residences in Carteret, New Jersey. The outdoor air sampling was conducted at monitoring stations, one in New York and one in New Jersey, located within a half mile of the selected study homes.

Indoor and ambient monitoring program samples for analysis of target compounds were collected at each site utilizing the DOH's Wadsworth Center for Laboratories and Research canister samplers. Samples were collected at 12-hour intervals every 12 days for nine months from July 10, 1990 through March 19, 1991. Samples were analyzed within 14 days of receipt by the laboratory. The canister analysis procedures used during the project were developed by the Wadsworth Center and are described in the Quality Assurance Project Plan (1). The method is based on Summa[®] treated sampler equipment for sample collection, with subsequent analysis by gas chromatography/mass spectrometry (GC/MS). The GC/MS method is based on the U.S. Environmental Protection Agency (EPA) Compendium Method TO-14. Data obtained from this investigation will aid in characterizing the relative risk of indoor and outdoor exposure for these homes tested in the Staten Island/New Jersey area.

Target contaminants analyzed in ambient and indoor air were:

Chloromethane	Trichloroethylene
Dichloromethane	Toluene
Hexane	Tetrachloroethylene
Chloroform	Ethylbenzene
1,1,1-Trichloroethane	m,p-Xylenes
Carbon Tetrachloride	o-Xylene
Benzene	

GC/MS Calibration

A multipoint calibration was performed for all analytes prior to the project and as necessary during the course of the analyses. This calibration consists of the analysis of calibration standards in the order of increasing concentration. The lowest concentration target compound present in the certified gas mixture is 1 ppbv or less in the calibration mixture. Concentrations for that compound will be ten times greater at the upper end of the calibration curve. After all the standards have been analyzed, linear regression is performed using compound concentrations and peak areas. To be acceptable as a calibration point, the observed

SUMMARY OF PROJECT

Analytical Results

The results for the 22 sampling dates, which include 250 field samples, have been presented in both a quarterly summary report as well as in a supplementary report which lists the results for each sampling date (2). Results are reported in ppbv. The minimum detection limit (MDL), as defined by the EPA, is one-half of the calculated detection limit. Since the average detection limit of the analyte was used for the first eight sampling dates, July 10 through October 2, 1990, one-half of this value was inserted in the data table as the MDL for results which were below the detection limit. For all subsequent sampling dates, October 14 through March 19, 1991, results which were less than the detection limit have been reported as half of the calculated detection limit value.

Samples collected during the first four collection dates were not analyzed for five of the target compounds. During this time the calibration mixture in use comprised eight of the fourteen standards. Two of the fourteen standards in the mixture subsequently used for calibration, m- and p-xylene, coeluted on our chromatography system.

Completeness

All of the samples received by the laboratory were analyzed.

Quality Control

Quality control involved the following procedures and analyses:

- 15 calibration runs
- 60 calibration check standards
- 44 laboratory blanks
- 19 trip blanks
- 4 performance audits
- 1 blind audit
- 20 duplicate analyses
- 7 field triplicates

The chronology for the calibration runs, check standards, laboratory blanks, and trip blanks is listed in Table 1. No target compounds were found in concentrations above the detection limits in either the laboratory blanks or the trip blanks. The analysis results and curves for the five-point calibrations are included in the Appendix of the SI/NJUATAP Air Quality Data Report (2).

value of any target compound calibration point must differ by less than 30 percent from the regression curve.

A single-point check of the multipoint calibration is performed using a mid-point in the calibration curve. Quantitation of the check sample is performed using the regression equation for the most recent multipoint calibration. The measured concentration must be within 30 percent of the true concentration to be considered acceptable.

A humidified ultra high purity air blank is analyzed to certify the cleanliness of the sample concentrations interface and the GC. The blank is considered acceptable if the concentrations of the target analytes are less than 0.2 parts-per-billion by volume (ppbv).

Canister Cleaning Criteria

On completion of an analysis, each canister is filled to 10 psi with humidified ultra high purity air in a 150°C oven, evacuated to less than 200 mTorr, and held at this temperature for 30 minutes. This procedure is performed eight times. Each canister is certified as clean prior to each use based on the criterion of not more than 0.2 ppbv for each target analyte using Gas Chromatography/Flame Ionization Detection (GC/FID).

Internal Quality Control

Quality control samples include the analysis of calibration check samples, laboratory blanks, audit samples, and trip blanks.

Calibration standards are used to determine the response range for the initial instrument calibration. Response factor checks are performed with standards containing the analytes of interest at a concentration in the mid-calibration range. These standards are compared to the most recent multipoint response factor in order to validate the calibration curve both prior to sample analysis and after the last sample.

Laboratory blanks are made in cleaned canisters by adding the appropriate amounts of humidified ultra-high purity air. Laboratory blanks are used to ensure that all reagents and laboratory instruments are interference free, and that background contamination remains less than 0.2 ppbv for each target analyte.

Performance audits are conducted to evaluate analytical accuracy. Canisters are spiked with target analytes by an outside laboratory.

Trip blank canisters are collected to help identify any sources of contamination related to shipping and handling the samples.

Representative analytical data, including a calibration check standard, system blank, cleaned canister, field sample, and trip blank are also contained in the Appendix.

SYSTEM EVALUATION

Performance Audits

Quality control samples of known concentrations were used in evaluating the system for indoor air analysis before beginning the SI/NJUATP. Four clean canisters were sent to NSI for spiking. The DOH analysis results may be compared with the NSI nominal concentration values in Table 2. All the results meet the data quality objectives for accuracy stated in Table 3.1 of the Quality Assurance Project Plan (1), having a relative error of +/- 50 percent.

Blind Audit

Blind performance audits are a means of evaluating analytical accuracy. Canisters are spiked by an outside laboratory with concentrations unknown to the analytical laboratory. Two canisters were spiked by NSI, however one leaked during return shipment to DOH. The results are given for the useable canister and compared to the concentrations added by NSI.

Accuracy

As presented in Table 3, the percent relative error calculated for the DOH analysis is less than 50 percent for 12 of the 13 analytes. The exception, vinyl chloride, which is not a target analyte for the SI/NJUATAP, had a relative error of 54 percent. The percent relative error for NSI results meets the data quality objective for 7 of the 13 compounds for which data is reported.

Precision

The DOH result for each analyte is the mean of a series of five replicate analyses of canister 32375. The precision of these analyses is presented in Table 4. The smallest range of these analyses is 0.1 and the largest is 0.4 ppbv. The percent relative standard deviation ranges from 6 to 18 percent, which meets the data quality objective of <30 percent for analytical precision.

DUPLICATE ANALYSIS

DOH/PEI

Five canisters were sent to PEI for duplicate analysis. The results may be compared with those of DOH in Table 5.

The relative percent difference is calculated as a measure of analytical precision. One-half of the minimum detectable level is substituted for the concentration when the results fell below the detection limit. Since there were many nondetectable results, these substituted values introduce many artificial data points.

The detection limit of PEI is lower than that of DOH. In samples where neither laboratory detects an analyte, the relative percent difference is only a measure of the difference between the two detection limits. For the five samples, 65 duplicate determinations for analytes are expected. Both laboratories report results above the detection limit in 37 of these duplicate determinations. The relative percent difference for 18 of these 37 is less than 30 percent, the data quality objective for analytical precision.

The standard deviations and percent coefficients of variation are calculated for the target analytes to compare the laboratory to laboratory variation in the duplicate analyses. The result is listed in Table 6. The percent coefficients of variation do not reflect the true variability between PEI and DOH because of the many substituted values for data points. Of the target analytes which were detected by both laboratories in all five samples, dichloromethane, benzene, toluene, and m,p-xylene, only the m,p-xylene coefficient of variation was less than 30 percent.

DOH/Radian

Six Samples Collected on 12/13/90

Results of these duplicate analyses are reported in Table 7. It can be seen that the DOH detection limit is much lower than that of Radian. Substitution of one-half of the minimum detection limit for nondetectable results introduces artificial data points. When neither laboratory detected an analyte, the relative percent difference is a comparison of the two detection limits. Both laboratories report results above the detection limit for 45 of the 78 data points. The relative percent difference for 18 of these is less than 30 percent, the data quality objective for analytical precision.

The standard deviations and percent coefficients of variation for the two laboratories are shown in Table 8. The difference in detection limits and difficulties of analysis at low levels of concentration are reflected in the interlaboratory variations which range from 180 to -90 percent. There were four target analytes which were detected by both laboratories in all six samples: benzene, toluene, m,p-xylene, and o-xylene. The coefficient of variation was less than 30 percent only for o-xylene.

The interlaboratory standard deviation is less than 1.0 for all analytes except toluene, which is almost 15. The relative percent differences for toluene, from Table 7, range from 13 percent for 904464 to 154 percent for 904463. In 904463, Radian

detected over 8 times the concentration that was detected by the DOH, 84 ppbv compared to 11 ppbv.

Nine Samples Collected on 3/19/91

The results of these nine duplicate analyses are reported in Table 9. Many analytes were not detected in the samples. DOH detected more analytes per sample than Radian. The relative percent differences are calculated where data is available. Both laboratories report results above the detection limit for 51 of the 117 duplicate determinations of analytes. The relative percent difference for 9 of these is less than 30 percent, the data quality objective for analytical precision.

Only two analytes, toluene and m,p-xylene, were detected by both laboratories in all nine samples. The standard deviations and percent coefficients of variation are presented in Table 10. The concentrations detected by Radian tend to be higher and deviate farther from the DOH results (see results for 911014 in Table 9). Hence the resulting large negative percent coefficients of variation. In 911014, Radian detected over three times the concentration level of toluene (100 ppbv compared to 29 ppbv) and over five times the concentration level of m,p-xylene (310 ppbv compared to 61 ppbv) detected by DOH. The resulting large relative percent differences for the two analytes, 110 and 134 percent, contributed to the large interlaboratory percent coefficients of variation.

FIELD TRIPLICATES

One sampling box was co-located with an existing sampling box at an existing site to permit field triplicate samples to be taken. Each box contained two canisters. Two canisters in one box and one from the other were filled simultaneously through a tee connector during one 12-hour sampling period. The remaining canister in the second box was filled in the 12-hour sampling period following the triplicate sample collection. This provided the "night" sample collected for that sampling date.

The results and statistical summaries for the field triplicate analyses are shown in Table 11. The first two canisters listed in each set were enclosed in a separate sampling box. The third canister of the triplicate was enclosed in a sampling box with the canister in which a sample was collected during the succeeding 12-hour period.

The analytical results show close agreement between the two samples housed within the same sampling box. In Table 11B the replicate in the third canister, 910848, (canister housed in separate sampling box) had 1,1,1-trichloroethane results over two times as high as that found in the paired samples, 910842 and 910845, and a trichloroethylene result over three times that of

the paired samples. The GC trace of of the cleaned canister (canister 02297) showed no detectable levels of any target compounds before sampling. However, it is noted that canister 02297 was last used on 12/1/90 for field sample 904310. In that sample, 648 ppbv of 1,1,1-trichloroethane was detected.

The percent relative standard deviations meet the data quality objective (<60%) for all analytes of all samples with the following exceptions:

- . trichloroethylene and tetrachloroethylene in Table 11B
- . tetrachloroethylene in Table 11D
- . hexane in Table 11F

In these triplicates results are identical for canisters in the same sampling box but the concentration detected in the third sample differs from the first two and causes the wider deviation from the mean.

- . hexane in Table 11G

All three samples for hexane in Table 11G have the same dispersion around the mean, 0.2. Since the mean concentration detected is 0.3, this indicates wide variation. However the concentration detected is close to the minimum detection limit where measurement precision is poor.

Pooled Coefficients of Variation

The coefficients of variation are combined to obtain an overall measure of precision among the seven triplicate sampling events. As presented in Table 12, the pooled coefficients of variation for all analytes meet the acceptance criteria with a variability less than 50 percent.

CONCLUSIONS

The statistical results of the performance audits and blind audit (Tables 2 and 3) demonstrate good analytical accuracy. The precision of the replicate analyses of the audit sample (Table 4) meets the data quality objective.

Duplicate laboratory analysis results (Tables 5 through 10) show difficulty in achieving data quality objectives for interlaboratory precision. Samples were first analyzed by DOH and then shipped to the second laboratory (PEI or Radian). The fact that the second analysis was performed at a different time and place after shipping and handling may have added to interlaboratory variation. Many of the data points fell below the limits of detection for the laboratories. Good precision becomes more difficult to achieve when measuring analytes at concentration levels close to the detection limit.

The determination of indoor air contaminants often involves analysis of components at or below the part-per-billion level. Although the analytical technology is capable of detection limits in this range, the result of this increased sensitivity is an increased variability in the resulting data. Difficulty is encountered in the interpretation of the significance and variability in the ensuing data.

Statistical results for the co-located samples (Tables 11 and 12) show overall sampling and analytical precision which meets the data quality objective.

REFERENCES

1. Quality Assurance Project Plan - Staten Island/New Jersey Indoor Air Study, Wadsworth Laboratories and Center for Environmental Health, New York State Department of Health, March 9, 1990.
2. Staten Island/New Jersey Urban Air Toxics Assessment Project - Air Quality Data Report, Wadsworth Center for Laboratories and Research, New York State Department of Health, June 1991, Revised December 1991.

TABLE 1

AIR CANISTER ANALYSIS QUALITY CONTROL

CALIBRATION STANDARDS*

Date of Calibration	Sample Analysis Dates
7/22,23/90	7/23,24/90
8/7,8/90	8/11,12,14/90
8/21/90	8/22,23,24,25,27,28,29,30/90
	9/3/90
9/6,7/90	9/10,12,14,15,18/90
9/20,22,24/90	9/24,25,26,27,30/90
10/1/90	10/2,3/90
10/10/90	10/17,18/90
11/2,5,6/90	11/7/90 - 1/4/91
1/2,3/91	1/4,5/91
1/9/91	1/9/91
1/11/91	1/14,15/91
1/16,17/91	1/18,19,21,22,23,28,29/91
2/19,20/91	2/20,21,25,26/91
3/14/91	3/19,20,23,25,26,27/91
4/2/91	4/3,4,5/91

* The calibration mixture used through 9/3/90 contained eight compounds. After this date a fourteen-compound mixture was obtained for use.

TABLE 1 (Continued)

CALIBRATION CHECK STANDARDS

Date	Run #	Concentration (ppbv)
8/11/90	0811A	0.33
8/24/90	0824B	2
8/27/90	0827A	2
8/28/90	0828A	2
8/30/90	0830A	2
9/3/90	0903A	2
9/12/90	0912B	6
9/13/90	0913D	3
9/26/90	0926A	1
9/28/90	0928C	5
10/17/90	1017A	5
11/7/90	1107B	0.5
11/12/90	1112A	0.2
11/12/90	1112B	0.2
11/12/90	1112C	0.2
11/13/90	1113A	0.2
11/14/90	1114C	2
11/15/90	1115C	2
11/19/90	1119A	2
11/20/90	1120A	2
11/27/90	1127B	2
11/30/90	1130C	0.5
12/2/90	1202A	0.5
12/4/90	1204B	0.5
12/11/90	1211B	0.5
12/12/90	1212B	12
12/13/90	1213C	0.5
12/14/90	1214C	0.5
1/3/91	0103B	5
1/3/91	0103C	10
1/3/91	0103D	10
1/5/91	0105B	0.5
1/10/91	0110A	0.5
1/10/91	0110C	1

TABLE 1 (Continued)

CALIBRATION CHECK STANDARDS

Date	Run #	Concentration (ppbv)
1/14/91	0114A	0.5
1/15/91	0115B	2
1/18/91	0118B	2
1/18/91	0118C	5
1/19/91	0119A	1
1/21/91	0121A	1
1/22/91	0122A	1
1/23/91	0123A	1
1/28/91	0128A	0.5
1/29/91	0129A	1
2/13/91	0213B	5
2/21/91	0221A	2
2/22/91	0222A	2
2/25/91	0225A	2
2/26/91	0226A	2
3/15/91	0315E	5
3/19/91	0319A	2
3/20/91	0320A	2
3/22/91	0322A	2
3/23/91	0323B	2
3/25/91	0325A	2
3/26/91	0326A	2
3/27/91	0327A	2
4/3/91	0403A	2
4/4/91	0404A	2
4/5/91	0405A	2

TABLE 1 (Continued)

LABORATORY BLANKS

Date	Run #
8/9/90	0809C
8/11/90	0811A
8/21/90	0821A
9/8/90	0908A
9/10/90	0910B
9/12/90	0912A
9/13/90	0913C
9/18/90	0918A
9/22/90	0922A
9/24/90	0924C
9/25/90	0925A
10/2/90	1002C
10/11/90	1011C
11/7/90	1107A
11/8/90	1108A
11/8/90	1108B
11/9/90	1109A
11/14/90	1114A
11/14/90	1114B
11/16/90	1116A
11/17/90	1117A
11/21/90	1121A
11/28/90	1128A
11/30/90	1130A
12/3/90	1203A
12/4/90	1204C
12/12/90	1212A
12/13/90	1213B
12/14/90	1214B
1/2/91	0102C
1/3/91	0103A
1/4/91	0104A
1/5/91	0105A
1/8/91	0108A
1/9/91	0109G
1/11/91	0111A
1/15/91	0115C
1/16/91	0116A
1/19/91	0119B
1/28/91	0128B
2/20/91	0220F
3/15/91	0315C
3/22/91	0322B
3/23/91	0323A

TABLE 1 (Continued)

Trip Blanks

Sample	Canister	Location	Collection Date	Analysis Date
902805	02755	7097-2C	8/3/90	8/25/90
902961	02528	7097-2B	8/15/90	9/3/90
903073	02531	0030-B1	8/27/90	9/15/90
903253	02379	0030-B2	9/8/90	9/24/90
903344	02535	7097-2A	9/20/90	9/27/90
903543	02288	7097-2B	10/2/90	10/17/90
903698	02535	0030-B1	10/14/90	11/7/90
903980	02530	7097-2B	11/7/90	11/19/90
903985	02032	0030-B2	11/7/90	11/20/90
904115	02761	7097-2B	11/19/90	12/3/90
904307	02758	0030-B1	12/1/90	1/4/91
904461	02379	7097-2B	12/13/90	1/4/91
910070	02374	0030-B1	12/25/90	1/18/91
910332	02375	7097-2C	1/6/91	1/21/91
910404	02115	0030-B3	1/18/91	1/28/91
910574	02032	7097-2B	1/30/91	2/13/91
910693	02378	7097-2B	2/11/91	2/25/91
910843	02112	7097-2C	2/23/91	3/15/91
911001	02758	7097-2B	3/19/91	4/3/91

TABLE 2

PERFORMANCE AUDITS (a,b,c)

Canister #:	02538			02529			02528			02530		
Analyst:	DCE	NSI		DCE	NSI		DCE	NSI		DCE	NSI	
Compound	% RE			% RE			% RE			% RE		
Dichloromethane	3.1	2.3	34.78	4.8	3.8	26.32	6.7	5.1	31.37	9.6	7.8	23.08
1,1,1-Trichloroethane	1.5	1.5	0.00	2.4	2.5	-4.00	2.7	3.3	-18.18	3.9	5.1	-23.53
Carbon Tetrachloride	3.4	3.1	9.68	5.2	5.3	-1.89	6.8	7	-2.86	10.4	10.7	-2.80
Benzene	2.7	2.8	-3.37	4.1	4.7	-12.77	5.6	6.3	-11.11	8.1	9.6	-15.63
Toluene	1.6	1.5	6.67	2.5	2.5	0.00	3.7	3.3	12.12	4.2	5.1	-17.65
Tetrachloroethylene	4.4	3	46.67	6.9	5.1	35.29	9.3	6.8	36.76	14.3	10.6	37.50
o-Xylene	2.1	1.4	50.00	3.1	2.4	29.17	3.8	3.2	18.75	5.3	4.8	10.42

a. NSI is an EPA contract laboratory.

b. Results are given in ppbv.

c. RE = relative error

TABLE 3

BLIND AUDIT (a,b,c)

CANISTER 32375

Compound	Theor Conc	DOB	NSI Conc	DOB % RE	NSI % RE
Vinyl Chloride	1.3	2	1.4	94	8
1,3-Butadiene	1.4	1.3	1.4	-7	0
Freon-11	0.7	0.7	4.2	0	500
Methylene Chloride	1.1	1.1	1.1	0	0
Chloroform	1.5	1.5	3.2	0	113
1,1,1-Trichloroethane	0.7	0.9	0.8	29	14
Carbon Tetrachloride	1.5	1.7	-	13	-
1,2-Dichloroethane	1.5	2.2	3	47	100
Benzene	1.3	1.6	1.8	23	38
Toluene	0.7	0.8	1.5	14	114
Tetrachloroethene	1.4	1.5	2.1	7	50
1,2-Dibromoethane	0.7	0.9	1.2	29	71
Chlorobenzene	0.7	0.5	0.8	-29	14
m-Xylene	0.7	0.7	1	0	43

a. Results are given in ppbv.

b. NSI is an EPA contract laboratory.

c. RE = relative error

TABLE 4
ANALYTICAL PRECISION (a,b)

CANISTER 32375

Compound	Run #					Mean	StdDev	RSD	Range
	1	2	3	4	5				
Vinyl Chloride	1.9	2	1.9	2	2.3	2.0	0.16	8	0.4
1,3-Butadiene	1.2	1.2	1.1	1.4	1.5	1.3	0.16	13	0.4
Freon-11	0.6	0.6	0.6	0.7	0.8	0.7	0.09	14	0.2
Methylene Chloride	1	1	0.9	1.2	1.3	1.1	0.16	15	0.4
Chloroform	1.4	1.4	1.6	1.5	1.7	1.5	0.13	9	0.3
1,1,1-Trichloroethane	0.8	1	0.9	0.9	1	0.9	0.08	9	0.2
Carbon Tetrachloride	1.5	1.7	1.5	1.7	1.9	1.7	0.17	10	0.4
1,2-Dichloroethane	2.1	2.2	2.1	2.3	2.4	2.2	0.13	6	0.3
Benzene	1.4	1.6	1.6	1.6	1.7	1.6	0.11	7	0.3
Toluene	0.7	0.8	0.7	0.9	0.8	0.8	0.08	11	0.2
Tetrachloroethene	1.3	1.4	1.4	1.4	1.9	1.5	0.24	16	0.6
1,2-Dibromoethane	0.8	0.9	0.8	0.9	1.2	0.9	0.16	18	0.4
Chlorobenzene	0.5	0.5	0.5	0.5	0.6	0.5	0.04	9	0.1
o-Xylene	0.6	0.7	0.6	0.7	0.9	0.7	0.12	17	0.3

a. Results are given in ppbv.

b. RSD = relative standard deviation

TABLE 5

DOH/PEI DUPLICATE ANALYSIS RESULTS(a,b,c,d,e)

ACCESSION #:	903067	903068	903070
CANISTER #:	2293	2294	2534
LOCATION:	0030-B1	7097-2B	7097-2B
COLLECTION DATE:	08/27/90	08/27/90	08/27/90
TIME OF DAY:	D	F	D

ANALYST:	DOH	PEI	DOH	PEI		DOH	PEI	DOH	PEI		DOH	PEI	DOH	PEI	
COMPOUND	DL	DL			KPD	DL	DL			KPD	DL	DL			KPD
Chloromethane	1.0	0.6	1.0	1.0	0	1.0	0.5	0.5 M	0.3 M	67	1.0	0.6	1.1	0.3 M	114
Dichloromethane	1.0	0.4	1.3	1.0	26	1.0	0.4	2.8	1.3	73	1.0	0.4	2.9	1.7	52
Hexane	1.0	0.8	0.5 M	0.7	33	1.0	0.7	2.5	2.0	22	1.0	0.7	6.3	3.6	55
Chloroform	1.0	0.4	0.5 M	0.2 M	86	1.0	0.4	0.5 M	0.1 M	86	1.0	0.4	0.5 M	0.2 M	86
1,1,1-Trichloroethane	1.0	0.4	1.3	1.4	7	1.0	0.4	1.0	0.9	11	1.0	0.4	0.5 M	0.7	33
Carbon Tetrachloride	1.0	0.6	0.5 M	0.2 M	86	1.0	0.4	0.5 M	0.2 M	86	1.0	0.4	0.5 M	0.2 M	86
Benzene	1.0	0.4	1.4	0.8	55	1.0	0.4	2.3	1.4	49	1.0	0.4	5.0	2.9	53
Trichloroethylene	1.0	0.4	0.5 M	0.2 M	86	1.0	0.4	0.5 M	0.2 M	86	1.0	0.4	0.5 M	0.2 M	86
Toluene	1.0	0.4	8.8	11.0	22	1.0	0.4	7.4	6.1	19	1.0	0.4	10.6	6.5	22
Tetrachloroethylene	1.1	0.4	0.6 M	0.2 M	93	1.1	0.4	0.6 M	0.2 M	93	1.1	0.4	0.6 M	0.2 M	93
Ethylbenzene	1.0	0.4	1.0	0.9	11	1.0	0.4	0.5 M	0.6	18	1.0	0.4	1.5	1.0	40
m,p-Xylene	2.1	0.4	1.0	2.6	89	2.1	0.4	3.2	2.0	46	2.1	0.4	3.9	2.9	29
o-Xylene	1.0	0.4	1.2	1.0	18	1.0	0.4	1.1	0.8	32	1.0	0.4	1.5	1.0	40

TABLE 5 (Continued)

ACCESSION #:	903071	903074
CANISTER #:	2538	2111
LOCATION:	0030-B2	0030-B3
COLLECTION DATE:	08/27/90	08/27/90
TIME OF DAY:	D	D

ANALYST:	DOH	PEI	DOH	PEI		DOH	PEI	DOH	PEI	
COMPOUND	DL	DL			RPD	DL	DL			RPD
Chloromethane	1.0	0.6	0.5 M	0.3 M	50	1.0	0.6	1.1	1.0	10
Dichloromethane	1.0	0.4	1.5	1.0	40	1.0	0.4	3.2	1.5	72
Hexane	1.0	0.7	1.3	1.3	0	1.0	0.8	0.5 M	0.4 M	22
Chloroform	1.0	0.4	1.4	1.2	15	1.0	0.4	0.5 M	0.2 M	86
1,1,1-Trichloroethane	1.0	0.4	1.3	1.4	7	1.0	0.4	0.5 M	0.7	33
Carbon Tetrachloride	1.0	0.4	0.5 M	0.2 M	86	1.0	0.4	0.5 M	0.2 M	86
Benzene	1.0	0.4	2.1	1.3	47	1.0	0.4	1.7	0.9	62
Trichloroethylene	1.0	0.4	1.1	0.8	32	1.0	0.4	0.5 M	0.2 M	86
Toluene	1.0	0.4	7.4	7.5	1	1.0	0.4	4.5	2.7	50
Tetrachloroethylene	1.1	0.4	0.6 M	0.2 M	93	1.1	0.4	0.6 M	0.2 M	93
Ethylbenzene	1.0	0.4	1.0	0.9	11	1.0	0.4	0.5 M	0.2 M	86
m,p-Xylene	2.1	0.4	4.6	3.0	42	2.1	0.4	2.1	1.1	63
o-Xylene	1.0	0.4	1.3	1.2	8	1.0	0.4	0.5 M	0.2 M	86

a. PEI is an EPA contract laboratory.

b. Results are given in ppbv.

c. DL = detection limit

d. M = Not detected at the detection limit. One-half of the minimum detectable level is entered as the concentration.

e. RPD = relative percent difference

TABLE 6

DOE/PEI ANALYTICAL PRECISION

COMPOUND	Std Dev	% Coefficient of Variation
Chloromethane	0.28	98
Dichloromethane	0.62	60
Hexane	1.12	163
Chloroform	0.05	18
1,1,1-Trichloroethane	0.05	33
Carbon Tetrachloride	0.00	0
Benzene	0.61	59
Trichloroethylene	0.01	3
Toluene	0.88	58
Tetrachloroethylene	0.00	0
Ethylbenzene	0.16	72
m,p-Xylene	0.29	22
o-Xylene	0.14	46

TABLE 7

DOH/RADIAN DUPLICATE ANALYSIS RESULTS(a,b)

ACCESSION #:	904455				904459				904460			
CANISTER #:	02755				02112				02763			
LOCATION:	0030-B1				0030-B1				0030-B2			
COLLECTION DATE:	12/13/90				12/13/90				12/13/90			
TIME OF DAY:	M				D				D			
ANALYST:	DOH	RAD	DOH	RAD		DOH	RAD		DOH	RAD		
COMPOUND	DL	DL			RPD			RPD				RPD
Chloromethane	0.2	0.4	0.8	0.4	60	0.9	0.2 M	127	1.0	0.2 M	133	
Dichloromethane	0.2	0.7	0.5	0.3 M	35	0.9	0.3 M	88	0.9	0.3 M	88	
Hexane	0.2	1.0	0.5	0.5 M	0	1.3	0.5 M	89	5.1	6.5	24	
Chloroform	0.2	0.4	0.2	0.2 M	8	0.3	0.2 M	47	0.5	0.2 M	92	
1,1,1-Trichloroethane	0.2	0.4	1.3	1.7	28	1.2	1.6	29	1.6	0.2 M	153	
Carbon Tetrachloride	0.2	0.4	0.1 M	0.2 M	69	0.1 M	0.2 M	69	0.1 M	0.2 M	69	
Benzene	0.2	0.5	0.8	1.1	30	1.6	2.6	46	4.1	2.9	35	
Trichloroethylene	0.2	0.5	1.2	1.0	15	1.3	0.9	39	0.8	0.2 M	109	
Toluene	0.2	0.8	8.7	14.8	52	10.3	12.8	22	31.6	93.8	99	
Tetrachloroethylene	0.2	0.6	0.3	0.3 M	5	0.8	0.3 M	95	1.1	0.7	42	
Ethylbenzene	0.2	0.6	1.0	0.7	31	1.6	0.8	63	3.3	2.1	45	
m,p-Xylene	0.2	0.3	3.5	3.2	10	6.3	3.5	57	12.1	8.6	34	
o-Xylene	0.2	0.4	1.9	1.2	42	2.6	1.4	63	5.3	3.5	42	

TABLE 7 (Continued)

ACCESSION #:	904463				904464				904466			
CANISTER #:	02754				02113				02027			
LOCATION:	0030-B3				0030-B3				0030-B2			
COLLECTION DATE:	12/13/90				12/13/90				12/13/90			
TIME OF DAY:	D				N				N			
ANALYST:	DOE	RAD	DOE	RAD	DOE	RAD	DOE	RAD	DOE	RAD	DOE	RAD
COMPOUND	DL	DL	DL	DL	RPD	RPD	RPD	RPD	RPD	RPD	RPD	RPD
Chloromethane	0.2	0.4	1.1	1.0	11	0.8	0.2 M	120	0.7	0.2 M	111	
Dichloromethane	0.2	0.7	12.6	11.2	12	13.5	13.2	2	0.6	0.3 M	53	
Hexane	0.2	1.0	1.9	2.8	39	0.4	0.5 M	22	1.8	2.5	33	
Chloroform	0.2	0.4	0.1 M	0.2 M	60	0.1 M	0.2 M	60	0.3	0.2 M	47	
1,1,1-Trichloroethane	0.2	0.4	2.8	2.1	30	1.6	1.5	9	1.3	1.6	23	
Carbon Tetrachloride	0.2	0.4	0.1 M	0.2 M	69	0.1 M	0.2 M	69	0.1 M	0.2 M	69	
Benzene	0.2	0.5	4.1	2.9	34	0.9	0.6	43	1.3	1.0	23	
Trichloroethylene	0.2	0.5	0.2	0.2 M	16	0.1 M	0.2 M	81	0.9	0.6	47	
Toluene	0.2	0.8	10.8	83.8	154	4.2	4.8	13	26.3	70.7	92	
Tetrachloroethylene	0.2	0.6	0.7	0.3 M	84	0.1 M	0.3 M	96	0.7	0.3 M	84	
Ethylbenzene	0.2	0.6	1.8	1.6	9	0.7	0.3 M	86	1.2	0.9	25	
m,p-Xylene	0.2	0.3	7.9	6.7	16	2.3	2.0	14	4.4	3.7	18	
o-Xylene	0.2	0.4	4.0	2.8	34	1.3	0.7	57	2.3	1.5	41	

a. Radian is an EPA contract laboratory.

b. Results are given in ppbv.

Abbreviations

D = day (6:00 to 18:00)

N = night (18:00 to 6:00)

DL = detection limit.

RPD = relative percent difference

M = Not detected at the detection limit. One-half of the minimum detectable level is entered as the concentration.

TABLE 8

DOE/RADIAN ANALYTICAL PRECISION FOR
 SAMPLES COLLECTED ON 12/13/90

Compound	Std Dev	% Coefficient of Variation
Chloromethane	0.11	22
Dichloromethane	0.21	39
Hexane	0.35	-90
Chloroform	0.07	104
1,1,1-Trichloroethane	0.33	180
Carbon Tetrachloride	0.00	0
Benzene	0.38	128
Trichloroethylene	0.12	55
Toluene	14.52	-46
Tetrachloroethylene	0.12	48
Ethylbenzene	0.18	35
m,p-Xylene	0.61	41
o-Xylene	0.21	20

TABLE 9

DOH/RADIAN DUPLICATE ANALYSIS RESULTS(a,b)

ACCESSION #:	911003			911004			911005		
CANISTER #:	02530			02289			02757		
LOCATION:	7097-2C			7097-2C			7097-2C		
COLLECTION DATE:	3/19/91			3/19/91			3/19/91		
TIME OF DAY:	D			N			D		
ANALYST:	DOH	RADIAN	DOH	RADIAN	DOH	RADIAN	DOH	RADIAN	
COMPOUND	DL	DL	RPD			RPD			RPD
Chloromethane	0.2	NA	0.8	-	-	0.6	-	-	0.90 - -
Dichloromethane	0.2	NA	0.9	0.6	43	0.7	-	-	0.90 0.45 67
Hexane	0.2	NA	ND	-	-	0.3	-	-	ND - -
Chloroform	0.2	NA	ND	-	-	ND	-	-	ND - -
1,1,1-Trichloroethane	0.2	NA	0.4	-	-	0.3	-	-	0.40 - -
Carbon Tetrachloride	0.2	NA	ND	-	-	ND	-	-	ND - -
Benzene	0.2	NA	1.1	0.6	65	1.0	0.5	76	1.10 0.56 65
Trichloroethylene	0.2	NA	ND	-	-	ND	-	-	ND - -
Toluene	0.2	NA	2.5	2.9	15	1.8	2.2	22	2.50 3.91 44
Tetrachloroethylene	0.2	NA	0.2	-	-	ND	-	-	ND - -
Ethylbenzene	0.2	NA	0.3	-	-	ND	-	-	0.30 - -
m,p-Xylene	0.2	NA	1.4	2.7	64	0.7	1.6	78	1.40 2.56 59
o-Xylene	0.2	NA	0.7	-	-	0.5	0.2	86	0.70 0.38 59

TABLE 9 (Continued)

ACCESSION #:	911006			911007			911010		
CANISTER #:	02761			02377			02382		
LOCATION:	0030-B3			0030-B2			7097-2A		
COLLECTION DATE:	3/19/91			2/23/91			3/19/91		
TIME OF DAY:	D			D			E		
ANALYST:	DOE	RADIAN	DOE	RADIAN	DOE	RADIAN	DOE	RADIAN	
COMPOUND	DL	DL	RPD			RPD			RPD
Chloromethane	0.2	NA	0.8	-	-	0.8	-	-	1.1 - -
Dichloromethane	0.2	NA	1.8	1.1	49	0.6	-	-	0.9 - -
Hexane	0.2	NA	ND	-	-	0.5	2.3	129	0.6 - -
Chloroform	0.2	NA	ND	-	-	0.4	0.4	5	0.5 - -
1,1,1-Trichloroethane	0.2	NA	1.9	1.5	26	0.9	-	-	0.5 1.0 63
Carbon Tetrachloride	0.2	NA	ND	-	-	ND	-	-	ND - -
Benzene	0.2	NA	0.8	-	-	0.9	0.4	83	2.0 1.0 63
Trichloroethylene	0.2	NA	ND	-	-	ND	-	-	ND - -
Toluene	0.2	NA	5.0	9.6	63	6.6	5.5	19	41.8 14.7 96
Tetrachloroethylene	0.2	NA	ND	-	-	0.4	-	-	ND - -
Ethylbenzene	0.2	NA	0.3	-	-	1.7	-	-	1.1 1.1 1
m,p-Xylene	0.2	NA	1.8	3.7	70	8.4	4.2	67	4.7 2.9 47
o-Xylene	0.2	NA	0.8	0.7	11	1.9	0.6	110	2.0 0.6 103

TABLE 9 (Continued)

ACCESSION #:	911012			911014			911016		
CANISTER #:	02526			02538			02525		
LOCATION:	0030-B3			7097-2B			0030-B2		
COLLECTION DATE:	3/19/91			3/19/91			2/23/91		
TIME OF DAY:	N			N			N		
ANALYST:	DOE	RADIAN	DOE	RADIAN	DOE	RADIAN	DOE	RADIAN	
COMPOUND	DL	DL	RPD			RPD			RPD
Chloromethane	0.2	NA	0.8	-	-	2.0	-	-	0.8 - -
Dichloromethane	0.2	NA	1.0	0.4	90	10.0	7.3	31	0.7 1.7 82
Hexane	0.2	NA	ND	-	-	0.9	-	-	1.0 2.1 72
Chloroform	0.2	NA	ND	-	-	1.0	0.2	123	0.3 - -
1,1,1-Trichloroethane	0.2	NA	1.9	1.8	7	0.5	-	-	1.2 0.3 120
Carbon Tetrachloride	0.2	NA	ND	-	-	ND	-	-	ND - -
Benzene	0.2	NA	0.5	0.2	74	2.3	1.0	80	1.6 0.8 69
Trichloroethylene	0.2	NA	ND	-	-	0.2	-	-	ND - -
Toluene	0.2	NA	2.1	2.6	22	28.9	99.8	110	6.8 5.0 31
Tetrachloroethylene	0.2	NA	ND	-	-	ND	-	-	0.6 0.3 82
Ethylbenzene	0.2	NA	0.2	-	-	24.7	64.9	90	1.3 - -
m,p-Xylene	0.2	NA	1.4	2.4	53	60.7	309.8	134	5.3 3.3 48
o-Xylene	0.2	NA	0.7	0.3	83	38.6	79.1	69	1.8 0.7 83

a. Radian is an EPA contract laboratory.

b. Results are given in ppbv.

Abbreviations

D = day (6:00 to 18:00)

N = night (18:00 to 6:00)

DL = detection limit.

RPD = relative percent difference

NA = not available.

ND = Not detected at the detection limit.

TABLE 10

DOH/RADIAN ANALYTICAL PRECISION
FOR SAMPLES COLLECTED ON 3/19/91

Compound	Std Dev	% Coefficient of Variation
Toluene	26.27	-491
m,p-Xylene	83.13	-302

TABLE 11A

FIELD TRIPLICATE ANALYSES (a,b,c)

Sample	Can	Location	Co Data	TD An Date	1	2	3	4	5	6	7	8	9	10	11	12	13
910682	02289	0030-B1	02/11/91 D	02/25/91	0.7	0.7	0.5	0.4	1.4	0.1 M	1.2	1.5	5.5	0.1 M	0.7	2.2	1
910687	02526	0030-B1	02/11/91 D	02/25/91	0.7	0.7	0.5	0.3	1.6	0.1 M	1.2	1.5	5.8	0.1 M	0.7	2.3	1
910689	02935	0030-B1	02/11/91 D	02/25/91	0.8	0.5	0.4	0.3	1.8	0.1 M	1	0.9	6.5	0.1 M	0.5	1.9	0.7

Compound		Average	Standard Deviation	NRSD
1	Chloromethane	0.73	0.06	8
2	Dichloromethane	0.63	0.12	19
3	Hexane	0.47	0.06	13
4	Chloroform	0.33	0.06	18
5	1,1,1-Trichloroethane	1.60	0.20	13
6	Carbon Tetrachloride	0.10	0.00	0
7	Benzene	1.13	0.12	11
8	Trichloroethylene	1.30	0.35	27
9	Toluene	5.27	0.68	13
10	Tetrachloroethylene	0.10	0.00	0
11	Ethylbenzene	0.63	0.12	19
12	m/p-Xylene	2.13	0.21	10
13	o-Xylene	0.90	0.17	19

TABLE 11B
FIELD TRIPLICATE ANALYSES (Continued)

Sample	Can	Location	Co Date	ID	An Date	1	2	3	4	5	6	7	8	9	10	11	12	13
910842	02115	0030-B1	02/23/91	D	03/19/91	0.8	0.6	0.2	0.2	1.5	0.1 M	0.6	1.2	3.7	0.1 M	0.3	1.1	0.6
910845	02031	0030-B1	02/23/91	D	03/19/91	0.8	0.5	0.1 M	0.2	1.5	0.1 M	0.7	1.2	3.4	0.1 M	0.3	1	0.6
910848	02297	0030-B1	02/23/91	D	03/19/91	0.9	0.5	0.3	0.3	3.1	0.1 M	0.6	4	3.2	0.3	0.3	1	0.3

	Compound	Average	Standard Deviation	UCL
1	Chloromethane	0.83	0.06	7
2	Dichloromethane	0.53	0.06	11
3	Hexane	0.20	0.10	50
4	Chloroform	0.23	0.06	26
5	1,1,1-Trichloroethane	2.03	0.92	43
6	Carbon Tetrachloride	0.10	0.00	0
7	Benzene	0.63	0.06	9
8	Trichloroethylene	2.13	1.62	76
9	Toluene	3.43	0.23	7
10	Tetrachloroethylene	0.17	0.12	72
11	Ethylbenzene	0.30	0.00	0
12	m/p-Xylene	1.03	0.06	6
13	o-Xylene	0.57	0.06	11

TABLE 11C

FIELD TRIPPLICATE ANALYSES (Continued)

Sample	Can	Location	Co Date	TD	An Date	1	2	3	4	5	6	7	8	9	10	11	12	13
910844	02536	7097-2C	02/23/91	D	03/19/91	0.8	0.5	0.4	0.1 M	0.2	0.1 M	0.6	0.1 M	1.5	0.1 M	0.1 M	0.6	0.3
910847	02114	7097-2C	02/23/91	D	03/19/91	0.8	0.4	0.3	0.1 M	0.2	0.1 M	0.6	0.1 M	1.4	0.1 M	0.1 M	0.6	0.3
910839	02754	7097-2C	02/23/91	D	03/19/91	0.8	0.5	0.3	0.1 M	0.1 M	0.1 M	0.7	0.1 M	1.4	0.1 M	0.1 M	0.6	0.2

	Compound	Average	Standard Deviation	ARSD
1	Chloromethane	0.80	0.00	0
2	Dichloromethane	0.47	0.06	13
3	Hexane	0.33	0.06	18
4	Chloroform	0.10	0.00	0
5	1,1,1-Trichloroethane	0.17	0.06	36
6	Carbon Tetrachloride	0.10	0.00	0
7	Benzene	0.63	0.06	9
8	Trichloroethylene	0.10	0.00	0
9	Toluene	1.43	0.06	4
10	Tetrachloroethylene	0.10	0.00	0
11	Ethylbenzene	0.10	0.00	0
12	m/p-Xylene	0.60	0.00	0
13	o-Xylene	0.27	0.06	23

TABLE 11D

FIELD TRIPPLICATE ANALYSES (Continued)

Sample	Can	Location	Co Date	TD	An Date	1	2	3	4	5	6	7	8	9	10	11	12	13
910916	02294	0030-B1	03/07/91	D	03/25/91	0.9	0.7	0.4	0.3	1.7	0.1 M	1.1	1.6	9.7	0.6	0.9	3.7	1.5
910921	02032	0030-B1	03/07/91	D	03/25/91	0.9	0.6	0.7	0.6	1.8	0.1 M	1.1	1.6	9.7	0.6	0.8	3.7	1.4
910926	02527	0030-B1	03/07/91	D	03/25/91	0.9	0.5	0.3	0.6	1.4	0.1 M	0.7	0.9	14.7	0.1 M	0.6	2.3	1.1

Compound		Average	Standard Deviation	NRSD
1	Chloromethane	0.90	0.00	0
2	Dichloromethane	0.60	0.10	17
3	Hexane	0.47	0.21	45
4	Chloroform	0.57	0.06	11
5	1,1,1-Trichloroethane	1.63	0.21	13
6	Carbon Tetrachloride	0.10	0.00	0
7	Benzene	0.97	0.23	24
8	Trichloroethylene	1.37	0.40	29
9	Toluene	11.37	2.89	25
10	Tetrachloroethylene	0.43	0.29	67
11	Ethylbenzene	0.77	0.15	20
12	m/p-Xylene	3.23	0.81	25
13	o-Xylene	1.33	0.21	16

TABLE 11E

FIELD TRIPLICATE ANALYSES (Continued)

Sample	Can	Location	Co Date	TD An Date	1	2	3	4	5	6	7	8	9	10	11	12	13
910925	02756	7097-2C	03/07/91	D 03/23/91	0.8	0.6	0.3	0.1 M 1.1	0.1 M 0.7	0.1 M 0.7	0.1 M 4.2	0.1 M 0.4	1.3	0.7			
910928	02759	7097-2C	03/07/91	D 03/23/91	0.8	0.7	0.3	0.1 M 1.3	0.1 M 0.7	0.1 M 4.5	0.1 M 0.4	1.3	0.7				
910919	02027	7097-2C	03/07/91	D 03/23/91	0.8	0.5	0.3	0.1 M 1.1	0.1 M 0.6	0.1 M 3.7	0.1 M 0.3	1	0.5				

	Compound	Average	Standard Deviation	NRSD
1	Chloromethane	0.80	0.00	0
2	Dichloromethane	0.60	0.10	17
3	Hexane	0.30	0.00	0
4	Chloroform	0.10	0.00	0
5	1,1,1-Trichloroethane	1.17	0.12	10
6	Carbon Tetrachloride	0.10	0.00	0
7	Benzene	0.67	0.06	9
8	Trichloroethylene	0.10	0.00	0
9	Toluene	4.13	0.40	10
10	Tetrachloroethylene	0.10	0.00	0
11	Ethylbenzene	0.37	0.06	16
12	m/p-Xylene	1.20	0.17	14
13	o-Xylene	0.63	0.12	19

TABLE 11F

FIELD TRIPLICATE ANALYSES (Continued)

Sample	Can	Location	Co Date	TD An Date	1	2	3	4	5	6	7	8	9	10	11	12	13
911003	02530	7097-2C	03/19/91	D 04/05/91	0.8	0.9	0.1 M	0.1 M	0.4	0.1 M	1.1	0.1 M	2.5	0.2	0.3	1.4	0.7
911005	02757	7097-2C	03/19/91	D 04/05/91	0.9	0.9	0.1 M	0.1 M	0.4	0.1 M	1.1	0.1 M	2.5	0.1 M	0.3	1.4	0.7
911002	02288	7097-2C	03/19/91	D 04/04/91	0.7	0.9	0.3	0.1 M	0.1 M	0.1 M	1.2	0.1 M	2.6	0.1 M	0.3	1.2	0.7

	Compound	Average	Standard Deviation	NRSD
1	Chloromethane	0.80	0.10	12
2	Dichloromethane	0.90	0.00	0
3	Hexane	0.17	0.12	72
4	Chloroform	0.10	0.00	0
5	1,1,1-Trichloroethane	0.30	0.17	57
6	Carbon Tetrachloride	0.10	0.00	0
7	Benzene	1.13	0.06	5
8	Trichloroethylene	0.10	0.00	0
9	Toluene	2.53	0.06	2
10	Tetrachloroethylene	0.13	0.06	45
11	Ethylbenzene	0.30	0.00	0
12	m/p-Xylene	1.33	0.12	9
13	o-Xylene	0.70	0.00	0

TABLE 11G

FIELD TRIPPLICATE ANALYSES (Continued)

Sample	Can	Location	Co Date	TD	An Date	1	2	3	4	5	6	7	8	9	10	11	12	13
911008	02374	0030-B1	03/19/91	D	04/03/91	0.9	0.6	0.3	0.5	1.6	0.1 M	1.2	1.7	10	0.4	0.8	3	1.3
911009	02292	0030-B1	03/19/91	D	04/03/91	0.8	0.6	0.5	0.5	1.4	0.1 M	1.2	1.6	9.7	0.3	0.7	3	1.2
911013	02535	0030-B1	03/19/91	D	04/03/91	0.9	0.6	0.1 M	0.6	1.9	0.1 M	0.9	1.2	8.4	0.2	0.6	2.6	1.1

Compound		Average	Standard Deviation	RSD
1	Chloromethane	0.87	0.06	7
2	Dichloromethane	0.60	0.00	0
3	Hexane	0.30	0.20	67
4	Chloroform	0.53	0.06	11
5	1,1,1-Trichloroethane	1.63	0.25	15
6	Carbon Tetrachloride	0.10	0.00	0
7	Benzene	1.10	0.17	15
8	Trichloroethylene	1.50	0.26	17
9	Toluene	9.37	0.85	9
10	Tetrachloroethylene	0.30	0.10	33
11	Ethylbenzene	0.70	0.10	14
12	m/p-Xylene	2.87	0.23	8
13	o-Xylene	1.20	0.10	8

- a. Results are given in ppbv.
- b. One-half of the minimum detectable level is entered as the concentration found in samples in which the concentration of the pollutant is less than the minimum detection limit of the analytical equipment.
- c. The first two canisters listed in each set were enclosed in a separate sampling box. The third canister of the triplicate was enclosed in a sampling box with the canister in which a sample was collected during the succeeding 12-hour period.

Abbreviations

Can = canister
 Co Date = collection date
 TD = time of day
 D = day (6:00 to 18:00)
 N = night (18:00 to 6:00)
 An Date = analysis date
 RSD = relative standard deviation
 M = minimum detectable level

Compounds

1 = Chloromethane	8 = Trichloroethylene
2 = Dichloromethane	9 = Toluene
3 = Hexane	10 = Tetrachloroethylene
4 = Chloroform	11 = Ethylbenzene
5 = 1,1,1-Trichloroethane	12 = m/p-Xylene
6 = Carbon Tetrachloride	13 = o-Xylene
7 = Benzene	

TABLE 12

ANALYTICAL PRECISION OF FIELD TRIPPLICATE ANALYSIS
EXPRESSED BY POOLED COEFFICIENT OF VARIATION

Compound	Pooled % Coefficient of Variation
1 Chloromethane	7
2 Dichloromethane	13
3 Hexane	46
4 Chloroform	13
5 1,1,1-Trichloroethane	32
6 Carbon Tetrachloride	0
7 Benzene	13
8 Trichloroethylene	33
9 Toluene	12
10 Tetrachloroethylene	43
11 Ethylbenzene	13
12 m/p-Xylene	13
13 o-Xylene	15

APPENDIX F

RADON

Section 2.3 of EPA document no. EPA 520-1 89-009,
"Indoor Radon and Radon Decay Product Measurement Protocols"

2.3 INTERIM PROTOCOL FOR USING ELECTRET ION CHAMBER RADON DETECTORS (EICs) TO MEASURE INDOOR RADON CONCENTRATIONS

2.3.1 Purpose

This protocol provides guidance for using electret ion chamber radon detectors (EICs) to obtain accurate and reproducible measurements of indoor radon concentrations. Following the protocol will help ensure uniformity among measurement programs and allow valid intercomparison of results. Measurements made in accordance with this protocol will produce screening measurements of radon concentration representative of closed-house conditions. Such screening measurements of closed-house concentrations have a smaller variability and are more reproducible than measurements made when the house conditions are not controlled.

If measurements with EICs are for a purpose other than a screening measurement, the investigator should follow guidance provided by EPA in "Interim Protocols for Screening and Follow-up Radon and Radon Decay Product Measurements" (EPA 520/1-86-014-1, 1987).

2.3.2 Scope

This protocol covers, in general terms, the equipment, procedures, and quality control objectives to be used in performing the measurements. It is not meant to replace an instrument manual, but rather provides guidelines to be adopted into standard operating procedures. Questions about these guidelines should be addressed to the U.S. Environmental Protection Agency, Office of Radiation Programs, Radon Division, Problem Assessment Branch (ANR-464), 401 M Street, S.W., Washington, D.C., 20460.

2.3.3 Method

Electret ion chamber radon detectors (EICs) have been described by Kotrappa et. al. (Kotrappa 1988). They require no power and function as true integrating detectors, measuring the average concentration during the measurement period.

EICs contain a permanently charged electret⁽¹⁾ which collects ions formed in the chamber by radiation emitted from radon decay products. When the device is exposed, radon diffuses into the chamber through filtered openings. Ions which are generated continuously by the decay of radon and radon decay products are drawn to the surface of the electret and reduce its surface voltage. The amount of voltage reduction is directly related to

⁽¹⁾ An electrostatically charged disk of Teflon[®].

the average radon concentration present during the exposure period. There are both short-term (2 to 7 day) and long-term (1 to 12 month) EICs that are currently marketed. The thickness of the electret affects the usable measurement period.

The electret must be removed from the canister and the electret voltage must be measured with a special surface voltmeter both before and after exposure. The difference between the initial and final voltage is divided first by a calibration factor and then by the number of exposure days to determine the average radon concentration during the exposure period. Electret voltage measurements can be made in a laboratory or in the field.

2.3.4 Equipment

The following equipment is required to measure radon using an EIC:

- A short-term or long-term EIC;
- An instruction sheet for the user and a shipping container with a label for returning the EIC(s) to the laboratory;
- A specially built surface voltmeter for measuring electret voltages before and after exposure;
- A data collection log.

2.3.5 Predeployment Considerations

The measurement should not be made if the occupant is planning remodeling, changes in the heating, ventilating and air conditioning system, or other modifications that may influence the radon concentration during the measurement period.

The EIC should not be deployed if the occupant's schedule prohibits terminating the measurement at the appropriate time.

2.3.6 Measurement Criteria

The following conditions should exist prior to and during a measurement to ensure that the conditions are as standardized as possible.

- The measurement should be made under closed-house conditions. To the extent reasonable, windows and external doors should be closed (except for normal entrance and exit) for 12 hours prior to and during the measurement period. Normal entrance and exit includes opening and closing of a door, but an external door should not be left open for more than

a few minutes. These conditions are expected to exist as normal living conditions during the winter in northern climates. For this reason and others discussed in Section 1.3.1, measurements should be made during winter periods whenever possible.

- Internal-external air exchange systems (other than a furnace) such as high-volume attic and window fans should not be operated during the measurement and for at least 12 hours before the measurement is initiated. Air conditioning systems that recycle interior air may be operated.
- In southern climates, or when the measurements must be made during a warm season, the standardized closed-house conditions are satisfied by meeting the criteria just listed. The closed house conditions must be verified and maintained more rigorously, however, when they are not the normal living conditions.
- Short-term measurements should not be conducted if severe storms with high winds or rapidly changing barometric pressures are predicted during the measurement period. Weather predictions available on local news stations may provide sufficient information to determine if this condition is satisfied.

A 12-month EIC measurement provides information about radon concentrations in a house during an entire year, so the closed-house conditions do not have to be satisfied to measure the annual average concentration over 12 months.

2.3.7 Deployment

The EIC should be inspected prior to deployment to see that it has not been damaged during handling and shipping.

2.3.7.1 Timely Deployment. Both long and short-term EICs should be deployed as soon as possible after their initial voltage is measured. Until an EIC is deployed, an electret cover should remain in place over the electret to minimize background loss of voltage.

2.3.7.2 Location Selection. The following criteria should be applied to select the location of an EIC within a room.

- A position should be selected where the detector will not be disturbed during the measurement period.

- The detector should not be placed near drafts caused by HVAC vents, windows, and doors.
- The detector should be placed at least 75 centimeters (30 inches) above the floor level and at least 10 centimeters (4 inches) from other objects.
- The detector should not be placed close to the exterior walls of the house.
- In general, detectors should not be placed in kitchens or bathrooms.

2.3.8 Retrieval of Detectors

Short-term EICs may be deployed for a two to seven day measurement period, and long-term EICs for one to twelve months. If the occupant is terminating the sampling, the instructions given to the occupant should tell the occupant when and how to terminate the sampling period. A deviation from the schedule by up to few days is acceptable for short-term EICs and up to three weeks for long-term EICs, if the time of termination is documented on the EIC information form. In addition, the occupant also should be instructed to send the EIC to the laboratory as soon as possible, preferably within a few days following exposure termination.

At the end of the monitoring period, the EIC should be inspected for any deviation from the conditions described in the log book at the time of deployment. Any changes should be noted. The EIC electret should be covered again using the mechanism provided.

2.3.9 Documentation

It is important that enough information about the measurement be recorded in a permanent log so that data interpretations and comparisons can be made. The information includes the following:

- The dates and start and stop times of the measurement;
- Whether standardized conditions, as previously specified, are satisfied;
- Exact location of the detector, on a diagram of the room and house, if possible;
- Other easily gathered information that may be useful, such as the type of house, type of heating system, and the existence of a crawl space;

- Serial number and supplier of detector along with a code number or description which uniquely identifies customer, building, room, and sampling position.

2.3.10 Analysis Requirements

In general, all EICs should be analyzed in the field or in the laboratory as soon as possible following removal from houses. A background correction must be made to the radon concentration value obtained because EICs have a small response to background gamma radiation.

2.3.10.1 Sensitivity. For a 7-day exposure period using a short-term EIC the lower level of detection (LLD) (Altshuler and Pasternak 1963) is about 0.3 pCi/L. For a long-term EIC, the LLD is also about 0.3 pCi/L.

2.3.10.2 Precision. The coefficient of variation should not exceed 10 percent (1 sigma) at radon concentrations of 4 pCi/L or greater. This precision should be monitored by using the results of duplicate detector analyses described in Section 2.3.11.3 of this protocol.

2.3.11 Quality Assurance

The quality assurance (QA) program for measurements with EIC detectors includes four parts: (1) calibration detectors, (2) known exposure (spiked) detectors, (3) duplicate detectors as a test of the precision and (4) control (blank) detectors to check for exposure during shipment or storage. The purpose of a QA program is to identify the accuracy and precision of the measurements and to assure that the measurements are not influenced by exposure from sources outside the environment to be measured.

The EPA has established the National Radon Measurement Proficiency (RMP) Program. This quality assurance program enables participants to demonstrate their proficiency at measuring radon and radon decay product concentrations. For further information please write to the U.S. Environmental Protection Agency; Radon Division; Mitigation, Prevention, and Quality Assurance Branch; National RMP Program; 401 M Street, SW; Washington, D.C., 20460.

2.3.11.1 Calibration Factors. Determination of calibration factors for EIC detectors requires exposure of detectors to known concentrations of radon-222 in a radon exposure chamber. Since EICs are also sensitive to exposure to gamma radiation (see Section 2.3.11.4), a gamma background measurement is also required.

The following guidance is provided to manufacturers and suppliers of EIC services as minimum requirements in determining the calibration factor.

- Detectors should be exposed in a radon chamber at several different radon concentrations or exposure levels similar to those found in the tested houses (a minimum of three different concentrations).
- A minimum of ten detectors should be exposed at each level.
- The period of exposure should be sufficient to allow the detector to achieve equilibrium with the chamber atmosphere.

2.3.11.2 Known Exposure Detectors. Both suppliers of EIC detector services and large users of these services should submit detectors with known radon exposures (spiked samples) for analysis on a regular schedule. Blind calibration detectors should be labeled in the same manner as the field detectors to ensure identical processing. The number of devices submitted for analysis should be a few percent of the total number of detectors analyzed. The results of the spiked detector analysis should be monitored and recorded and any significant deviation from the known concentration to which they were exposed should be investigated.

2.3.11.3 Duplicate (Colocated) Detectors. Duplicate EICs should be placed in enough houses to monitor the precision of the measurement. This will usually be approximately 10 percent of the houses to be tested each month or 50, whichever is smaller. The duplicate devices should be shipped, stored, exposed, and analyzed under the same conditions, and not identified as duplicates to the processing laboratory. The samples selected for duplication should be systematically distributed throughout the entire population of samples. Groups selling measurements to homeowners can do this by providing two detectors instead of one to a random selection of purchasers, with instructions to place the detectors side-by-side. Consideration should be given to providing some means to ensure that the duplicate devices are not separated during the measurement period. The analysis of duplicate data should follow the methodology described by Goldin in section 5.3 of his report (Goldin 1984). The method should achieve a coefficient of variation of 10 percent (1 sigma) or less at radon concentrations of 4 pCi/L or greater. Consistent failure in duplicate agreement indicates an error in the measurement process that should be investigated.

2.3.11.4 Control EICs for Background Gamma Exposure and Electret Stability Monitoring. Electrets should exhibit very little drift in surface voltage due to internal electrical instabilities.

Neither the short-term or the long-term electrets should show voltage reductions of more than that which they exhibit when exposed to 0.3 pCi/L. A minimum of 5 percent of the electrets, or 10, whichever is smaller, should be set aside from each shipment and evaluated for voltage drift. They should be kept covered with protective caps in a low radon environment and analyzed for voltage drift over a time period similar to the time period used for those deployed in homes. Any voltage drift found in the control electrets of more than 2 volts per week for short-term electrets or 1 volt per month for long-term electrets should be investigated.

EICs also are sensitive to background gamma radiation. The electret voltage drop due to the background gamma radiation needs to be assessed so that an appropriate correction can be made to the measured concentration value. This background voltage drop should be subtracted from the total voltage drop exhibited by the electret, to produce a net voltage difference due only to the exposure to the ions produced by the decay of radon in the EIC chamber. A background correction of 0.8 pCi/L is routinely subtracted from both long and short-term EIC readings to correct for an average background value of 10 uR/hr. This background correction is made by the analysis laboratory or by the user if the detector is read in the field. In cases where higher than normal background radiation is suspected or known to exist, a gamma background measurement should be made (preferably with an energy-compensated scintillometer), and an additional correction of 0.08 pCi/L for each additional uR/hr should be made.

New York State Study

OUTDOOR MEASUREMENT

Enclosed are the radiation monitors and metal shelter necessary to monitor outdoor radon-222 concentrations. Please place the boxes marked "transit TLD's" into the mail as soon as you receive them. The present study requires deployment of the two long-term E-PERM's and a set of TLD-15's at two houses.

The shelters are designed to be attached to a chain link fence or suitable post, located at least three feet from permanent buildings, masonry walls, or electrical transformers. Inside each box is an adjustable post clamp bracket for attaching the shelter to a standard chain link fence post of 1 1/2 - 2 inches in diameter. The bracket connects to the back of the shelter by using the two center bolts. The shelter must be mounted approximately 39 inches (1 meter) above the ground level. If you have any questions in mounting the shelter, please call Roger Shura at (702) 798-2450.

Place the long-term E-PERM's into the shelter, along with the background TLD's and the TLD data card. Fill in the start dates and times on the data cards. Unscrew the tops of the E-PERM's and shut the lid of the shelter. PLEASE SAVE THE BOXES FOR RETURN SHIPPING!

A measurement time period of 3 months has been selected for the outdoor E-PERM's and TLD's.

INDOOR MEASUREMENTS

Eight short-term E-PERM's are enclosed for the indoor measurements to be conducted (two apiece) in four homes. Instructions for deployment of the indoor E-PERM's are enclosed. A time period of twelve days has been selected for the indoor detector measurements.

If you have any questions, please call Dick Hopper or Rhonda Rankin at (702) 798-2469.

Instructions for using the E-PERM detector

Pre-test Information

Do not conduct test if you are planning extensive remodeling or changes in your heating or air-conditioning system that may drastically alter the normal air flow in your home while using this device.

Do not start test if your schedule prohibits ending the measurement after the maximum ~~seven~~ ^{seven} days or if you cannot return or mail the E-PERM to the laboratory at the end of the test period.

Do not operate high volume attic or window fans or air exchange systems (other than normal furnace/air conditioner) for 12 hours prior to or during the test period.

Do not conduct the test if severe winds or thunderstorms are predicted for the test period.

Set-up Instructions

A suitable test site must be chosen for the E-PERM canister. Choose a room that is regularly occupied on the LOWEST LEVEL of your home. Do not choose a location near drafty areas such as windows, doors or under heating/air conditioning vents, near excessive heat such as fireplaces or radiators or in the direct sunlight. Do not choose a location near the outside walls of your home.

Remove the E-PERM from the box. Save this box for returning the device to the laboratory.

Record the ROOM LOCATION and FLOOR of the home you have chosen on the attached sample collection card.

Place the canister at your selected location. It must be placed where it will remain undisturbed throughout the measurement period. Place it on a flat table or shelf at least 2 feet above the floor and with the detector at least 4 inches away from all other objects so nothing will limit air-flow around canister.

To start the test, unscrew the plastic lid on top. The lid will pop up about 2 inches above the canister. Your E-PERM is now ON and the measurement period has begun.

Record the START TIME and DATE on the attached sample collection card.

FIELD ENTRY

LOC. # _____

Elect. # 3129 Chmbr. # 3129

St. Time _____ End Time _____

St. Date _____ End Date _____

Comments _____

Office of Radiation Programs LV
P.O. Box 98517
Las Vegas, NV 89193-8517

Init. _____

Removal Instructions

At the end of your test period, to stop the exposure, screw the lid on top of the canister back into place. The E-PERM is now off and the measurement period is over.

Record the STOP TIME and DATE on the sample collection card. In the REMARKS section of the data card, record any unusual weather conditions or if the E-PERM was dropped or knocked over.

Send the E-PERM to the laboratory in a shipping box with the return address label provided.

If you have any questions, please contact Rhonda Rankin at the Office of Radiation Programs in Las Vegas at (702) 798-2469.

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE \$300



PRIORITY

NO POSTAGE
NECESSARY
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IN THE
UNITED STATES



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U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RADIATION PROGRAMS
P.O. BOX 98517
LAS VEGAS, NV 89193-8982

Attn: R. Rankin
EAX -3

8517

A1302

SI/NJ UATAP INDOOR AIR MONITORING SITES

SUMMARY SHEET

PAGE

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- B. DAILY ACTIVITY LOG FOR THE 24-HOUR PERIOD PRIOR TO SAMPLING
- C. HUMAN ACTIVITY FACTORS
 - 1. General Information for Occupants
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NEW YORK STATE DEPARTMENT OF HEALTH
BUREAU OF TOXIC SUBSTANCE ASSESSMENT
INDOOR AIR QUALITY RESIDENTIAL QUESTIONNAIRE

Date Prepared:
Prepared By:
Title:

Complete the following questionnaire for each household sampled:

A. GENERAL INFORMATION

(1)a. Head of Household: Name: _____

Address: _____

City: _____

County: _____

Home Phone No.: _____

Business Phone No.: _____

b. How many years have you resided at this address? _____

(2) Owner (If different than above)

Name: _____

Address: _____

City: _____

Phone No.: _____

B. DAILY ACTIVITY LOG FOR THE 24-HOUR PERIOD PRIOR TO SAMPLING

Answer the following for the 24-hour period just prior to sampling:

Date:

1. Did you cook breakfast?
Time?
2. Did you cook lunch?
Time?
3. Did you cook dinner?
Time?
4. Did you cook or bake anything special which add cooking time?
Time?
5. Did you turn on the kitchen ventilation fan while cooking? How long?
6. Did you use any chemical cleaning agents? If yes, which room(s) did you clean? State date, time and type(s) of cleaning materials used in each room.

7. Do you smoke? Did you have any guests that smoked? What type of smoking (cigarette, cigar, pipe, etc.). Date, time and room in which they smoked?

8. Was a spray or solid air freshener used in the house? What brand? Date, time and room in which it was used?

9. Did you open any windows? In which rooms did you open the windows? Between what hours were the windows open?

- Did you have any other activities during the last 24 hours?

10. Did you vacuum? What brand of vacuum cleaner did you use? Date, time and time spent vacuuming each room?
-
-

11. Did you use a fireplace? When?
-

12. If you have an attached garage, was a car in the garage? Was it running (driven in or out) during the day?
-

13. What personal toiletries were used in your home?
-

14. Did you use the washing machine or dishwasher?
-

15. How many individuals took showers and what the approximate length of each.
-

16. Did you participate in any hobbies that require solvents?
-

17. Was anything in the house painted during the last 24 hours? In what room?
-

18. Was your general heating system used? How many hours?
-

19. Was a kerosene heater operated? For how long?
-

20. Has any construction or handy work been done in the home that required wallboarding, installing carpets, etc.? If yes, please explain.
-
-
-

C. HUMAN ACTIVITY FACTORS

Answer each question for each occupant presently living at this residence.

Occupant

1 2 3 4 5 6 7 8 9 10

1. General Information:

- a. Name:
- b. Age:
- c. Sex
- d. Occupation (including students)
- e. How many years at this occupation?
- f. If a student, at which school?
- g. Does the person live somewhere else for any part of the year (ex. college student)?
- i. If yes, what percentage of the year do they live at this residence?

2. Occupancy Profile. Please state the average amount of time (in hours) each person spends:

- a. in the home (weekday)
- b. in the home (weekend)
- c. just outside the home (weekday)
- d. just outside the home (weekend)
- e. at the workplace or school
- f. in transit
- g. in other people's homes
- h. in places of business
- i. in restaurants or bars
- j. in all other locations

3. Presence in home during use of stove:

- a. Weekdays: breakfast _____
lunch _____
dinner _____
- b. Weekends: breakfast _____
lunch _____
dinner _____

4. Smoking Profile:

- a. Does the person smoke?
- b. Cigarettes, pipe, cigar, other?
- c. What hours during the day does he or she smoke in this residence?
- d. In which rooms?

5. Activity Profile:

What hours is the person home?
(example 6:00 pm to 8:00 am)

- a. Weekdays
- b. Weekend days

D. DESCRIPTION OF HOME SURROUNDINGS

1. Residence location:
urban industrial
urban residential
suburban
rural
2. If suburb or rural, specify distance and direction of nearest city?
3. (i) What size is the lot? _____ (sq. ft. or acres)
Lot type? Corner Lot? _____
Interior lot (lot bounded by street on one side)? _____
Double-fronted lot (interior lot bounded by a street on front and back)? _____
4. (ii) Draw a sketch of the lot and approximate location of the residence. Include north/south orientation. Label streets, surrounding buildings, etc. Include location of well, pool, garden and any other important landmarks.
5. a. What is the distance from residence to the road?
b. Is the nearest road:
heavily travelled _____
moderately travelled _____
rarely travelled _____
c. Is the nearest road:
paved _____
unpaved _____
other _____
d. What is the approximate percentage of trucks compared to total vehicles on this road?
6. What is the nearest major roadway? Describe direction and distance from roadway?
- 7a. Describe the land surrounding the house.
clay _____
bedrock _____
shale _____
soil _____
sand _____
gravel _____
other _____
(b) Is the land surrounding your home:
dry _____
average _____
damp _____
Explain: _____
8. Are there any construction, demolition, or earthmoving activities in the vicinity of this residence?

9a. Relative to the surrounding terrain of one square block; is this residence:

hilltop _____ hillside _____ valley _____ plain _____

b. Relative to the surrounding terrain of one square mile, is this residence:

hilltop _____ hillside _____ valley _____ plain _____

10a. Density of trees surrounding residence?

Dense _____ Moderate _____ Sparse _____

b. Types of trees:

alder _____
ash _____
oak _____
birch _____
cedar _____
elm _____
fir _____

hickory _____
maple _____
pine _____
popular _____
syacamore _____
walnut _____
other _____

11a. Is this residence on a shoreline?

- b. Type of body of water?
- c. Distance from body of water?
- d. Shoreline flora or fauna?
- e. Are there stagnant backwaters?

12a. Is there a swimming pool on the property?

- b. Where is it located in relation to the house?
- c. What chemicals are used to maintain the pool (Brand type)?
- d. Where are these chemicals stored?

13a. Has the house ever been fumigated?

- b. What was the problem (termites, ants, etc.)?
- c. Who did the work?
- d. Where was the pesticide applied?
- e. What pesticides were used?
- f. What was the method of application?
- g. To the best of your knowledge, was the pesticide properly applied?

h. If improperly applied, indicate conditions:

introduction to ducts on forced air systems	_____
failure to properly grout sub-slab applications	_____
direct to soils in crawl space areas	_____
seepage through walls and/or floors	_____
direct to interior surfaces	_____
floor spillage	_____
failure to properly seal borings through	_____
concrete floor or wall	_____
other	_____

- 14a. Do you have a garden?
 - b. What is grown?
 - c. Distance and direction from house?
 - d. What chemicals (fertilizer, pesticide, herbicides) are used?
 - e. How are they applied (directly to ground, sprayed)?
 - f. Where are the chemicals stored?
- 15a. What products do you use to maintain your lawn (fertilizer, crab grass killer, etc.)?
 - b. How are these chemicals applied?
 - c. Where are these chemical stored?
- 16a. Is this residence located on or near a farm?
 - b. If near, describe distance and direction?
 - c. Method of pesticide, herbicide application?
- 17a. Are the trees in your location sprayed with any chemicals?
 - b. What are they sprayed for?
- 18a. Are there vacant lots or bodies of stagnant water near this residence?
 - b. Describe type, distance, and direction?
 - c. Does anyone spray for mosquitos, weeds, etc.?
 - d. What is sprayed?
- 19. Describe type, location and distance of nearest industry (industries) (if applicable).
- 20. Describe type, location and distance of the nearest commercial establishment (if applicable).
- 21. Describe type, location and distance of nearest landfill or dumpsite (if applicable).
- 22. Describe location and distance of power lines and power stations.
- 23. Describe location and distance of transmission lines, broadcast towers, or microwave relay stations (if applicable).
- 24. Describe location and distance to the nearest gas stations, oil storage tanks, propane storage and dispenser facilities.
- 25. Describe location and distance to a professional cleaning establishment (if applicable).
- 26. Describe location and distance of nearest airport (if applicable).
- 27. Describe location and distance to any large parking lots, bus stations, train stations (if applicable).

28. Is there anything else about your outdoor environment that you feel may contribute to chemicals in the air?
29. In your opinion, is the air seriously polluted in your community? Why do you think so?
30. In your opinion, is the water seriously polluted in your community? Why do you think so?
31. In your opinion, is the soil seriously polluted in your community? Why do you think so?
32. To the best of your knowledge, what was located on this land prior to this building?

E. WATER SUPPLY

1a. Source of water:

Personal Well _____
Public Well _____
Public Lake or River _____
Other _____

**b. If public water supply, when was system built?
What type of pipes were used?**

c. Is the water chlorinated?

d. If private well:

Well diameter _____
Well depth _____
Depth to bedrock _____
Feet of casing _____
Well capacity _____

Type of pump _____
Well yield _____
Type of storage tank _____
Condition of storage tank _____
Size of storage tank _____
Type of treatment _____

2. Do you use any water treatment systems (water softener, filters)? Describe.

3. General water quality:

**(a) Are there any taste and/or odor problems? _____
Describe**

How long has the taste and/or odor been present?

**(b) Are there any color or cloudiness problems? _____
Describe**

**(c) How long has this been a problem? _____
Are there any scaling or staining problems? Describe.**

4. Type of water heater:

Gas, Oil, Electric _____
Make, Model & Year _____
Location in House _____

F. WASTE DISPOSAL SYSTEM

1. Public Sewer _____
 Septic Tank _____
 Other _____
2. Distance of waste disposal system from well?
3. If you have a septic tank, have you had any problems with
 it? Has it ever been replaced?
- ? Has the septic tank ever been pumped out and when ?

G. HEAT, VENTILATION, AIR CONDITIONING SYSTEMS (HVAC)

1. Heating System

a.(i) Primary Heating System:

Hot air circulation _____
Hot water circulation _____
Steam radiators _____
Electric _____ Central _____ Radiant _____
Heat Pump _____
Solar _____ What type of heat storage bed is
used? _____
Other _____

(ii) Fuel Type:

Natural Gas _____
Fuel Oil _____
Electric _____
Wood _____
Coal _____
Sun _____

b. Secondary Heating System

Fireplace Insert _____
Woodburning Stove _____
Space Heaters:
Electric _____
Kerosene _____

c.(i) Heat distribution is accomplished by:

Ducts _____
Radiators _____
Other _____

(ii) Are the ducts lined or covered with an insulating material? _____

If yes, what type of insulation? _____

d.(i) Where is the primary heat source located? _____

Basement _____
Living Area _____ Specify Where _____
Other _____

(ii) If the fuel type is oil, where is the oil tank located?

Is there any leakage?

What is the condition of the tank?

(iii) Furnace: Make _____
Model _____
Year _____
Insulation: Type _____
Condition of door gaskets: _____

e. Is this heating system zone controlled?

f. Is there a system to recover heat from exhaust air?

g. Fireplaces and woodburning stoves:

- (i) Does this residence have fireplaces? _____
How many? _____ Where are they located? _____
- (ii) Does this residence have woodburning stoves? _____
How many? _____ Where are they located? _____
- (iii) Were the fireplaces and woodburning stoves
professionally installed? _____
- (iv) Do the stovepipes on the woodburning stoves have
cracks, leaks, or seem to badly fitted? _____
- (v) Are there frequent down drafts? _____
- (vi) Are there glass enclosures in front of
fireplaces? _____
- (vii) When was flue or stove pipe last cleaned? _____
- (viii) Is a flue damper installed? _____ Motorized? _____
- (ix) Is there a recovery system for flue gas, heat?
_____ differential pressure _____

h. Other combustion sources:

Do you frequently burn:

candles _____
insence _____
oil lamps _____
kerosene lamps _____
other _____

2. Cooling System

a. Type of cooling system:

Electric _____
Individual Units _____
Ventilation Fans _____
Other _____

b. Specify location of cooling system or location of
individual units?
What is the capacity?
Make, Model, Year?

3a. Ventilation and Indoor Air Treatment - Specify all types:

Humidifiers: Location _____

Model and Year: _____

Dehumidifiers: Location _____

Model and Year: _____

Air filtration: Location: _____

Model: _____

Year: _____

Sorption Devices: Location _____

Model: _____

Year: _____

Electrostatic Precipitator: Location: _____

Model: _____

Year: _____

Ozonator: Location: _____

Model: _____

Year: _____

Controlled Ventilation System:

Type: _____

Location: _____

Model: _____

Year: _____

Air Diffusion Equipment:

Type: Grilles

Slot Diffusers

Ceiling Diffusers

Perforated Ceiling

Location

Model

Year

Furnace Filters: Model _____ Year _____

H. INDOOR-OUTDOOR ENERGY AND AIR FLOW

1. Would you consider this residence to be:

very drafty _____
somewhat drafty _____
fairly air tight _____
very air tight _____

2a. Insulation

(i) Type: (check all that are present in this residence)

Fiberglass _____
Urea-formaldehyde foam _____
Cellulose _____
Polyurethane _____
Asbestos _____
Rock Wool _____
Vermiculite _____
Other _____

(ii) For each type of insulation used, specify location and thickness:

Type	Thickness (in.)	Visibly Exposed
Outside walls		
Roof rafters		
Attic floors		
Crawl space		
If concrete-slab, construction under bottom floor		
Other		

3. Other conservation measures (check all used):

Storm windows	_____
Operable insulating shutters	_____
Storm doors	_____
Caulking and weatherstripping	_____
Pointing and Filling (remove gaps in aged brick or stone)	_____
Decrease window area	_____
Elimination of fireplace	_____
Recirculation of kitchen fan	_____
Vestibule doors replacing single doors	_____
Automatic door closers	_____
Outdoor landscaping (windbreak)	_____
Shading devices for windows	_____
Reduce internal electrical loads	_____
Use fluorescent lighting	_____
Automatic pilot lights in gas appliances	_____

Proper ventilation of heat-producing appliances	_____
Timers on light switches in infrequently used areas	_____
Installation of high efficiency appliances	_____
Reduce ratio of building envelope/floor area	_____
Ventilate attic spaces	_____
Lower ceiling height	_____
Nighttime temperature setback	_____

I. BUILDINGS DESIGN AND MATERIALS

1. Exterior of Residence

a. Are blueprints or other building records available, should they be needed?

b. Is this a:

single family residence	_____
multi-family residence	_____
apartment complex	_____
town house	_____
condominium	_____
other	_____

c. House foundation:

Concrete-slab type	_____
Basement type	_____
Pier and Post type	_____

d. (i) If multi-family, apartment, townhouse, or condominium, how many units are in your building?

(ii) What is the location of your unit?)Floor, Corner, etc.) Describe.

(iii) What is the location of the elevator in relation to your unit?

(iv) What is the location of the stairwells in relation to your unit?

(v) What is the location of the laundry in relation to your unit?

(vi) What is the location of the incinerator in relation to your unit?

For home in multi-unit building skip to question f.

e. If single family dwelling:

One story	_____
Raised ranch or bi-level	_____
Split level	_____
Story and a half	_____
Two story	_____
Three story	_____

f. (i) Height of building _____ (ft)
(ii) height of one-story _____ (ft)

- g. (i) When was this residence built?
(ii) What major renovations have been made since this residence was building (ex., additional rooms, replace roof, etc.)?
- h. (i) Has there every been a fire in the house?
(ii) If yes, in what section?
(iii) What was the extent of the damages and what was done to repair these damages?

- i. (i) What are the exterior dimensions of the building?
_____ ft. x _____ ft.
(ii) What is the external color of the building walls?
_____ ft. x _____ ft.

space →

- (iii) What is the material covering the external building walls?

brick _____
stone _____
aluminum siding _____
wood shingles or siding _____
underlaying material _____

- j. (i) Number of external doors (excluding sliding glass)? _____

What material are they made from:

Solid Wood _____
Wood Veneer _____
Metal doors _____
Other _____

Number of sliding glass doors _____

Orientation of doors N SE W NW NE SW SE

Area per door _____ (ft²)

k. Windows

- (i) frame material:

Wood _____
Aluminum _____
Other _____

- (ii) glazing:

Single _____
Double _____
Triple _____

- (iii) storm windows _____ Yes _____ No

- (iv) glass area as percentage of floor area
(excluding glass doors) _____%

(v) Is the structure oriented so that the glass area is distributed in a particular direction? _____
If yes, what is the approximate distribution of glass area by sides of structure?

North _____% South _____% East _____% West _____%
NW _____% SW _____% NE _____% SE _____%

1. Roof

(i) Type: Peak or Gable _____ (height = _____)
Flat _____ Built-Up _____
Other _____

(ii) Roofing material

slate _____
roofing shingle _____
metal _____
clay tile _____
tar paper _____
nylon sheets _____
wood shakes _____
asbestos sheets _____
asbestos shingles _____

2. Garage

a. Is there a garage?

b. Garage Type: Attached _____
Detached _____
Built-in _____
Other _____

c. If attached or built-in, what rooms are adjacent to or above the garage? Where are doors that lead from the garage to the house?

d. If attached or built-in, how many vehicles are generally parked in garage?

Types of vehicles?

Do you warm-up the car in the garage?

How long on the average?

e. If attached or built-in, do you have lawnmowers, snowblowers or other power machinery stored in the garage?

Is this machinery started or used in the garage?

f. What chemicals are stored in the garage (lawn and garden chemicals, pool chemicals, gas containers, paints, etc.)? List all brands.

3. Interior of Residence

a. Sketch a floor plan of the residence. Include North/South orientation, location of heating, cooling water, ventilation systems. Use one page for each floor - include basement and attic if applicable. Include approximate locations of sample collections(s).

b. Total floor area in structure or unit? _____ (ft²)
Total floor area that is below grade? _____ (ft²)

c. Attic

Does this residence have an attic?

Is the attic finished as living accommodations, or used as storage?

Entrance to attic:

Stairway or pull down ladder?

Where is entrance located?

What is stored in attic? (List all consumer products, paints, etc.).

d. Basement

Does this residence have:

full basement	_____
half basement	_____
crawl space	_____
no basement	_____
other	_____

Is the basement heated:

full	_____
half	_____
crawl space	_____
not heated	_____

If fully or partially unheated, is there insulation under floor?

If yes, type and amount?

Is the basement finished _____ Unfinished _____

Is there seepage _____ or flooding _____ of water in the basement?

What is the basement used for:

living space _____ work space _____
storage _____ recreational _____

What chemicals are stored in the basement?

Is any power machinery stored and/or used in basement?

Where do doors from basement lead? Are they usually open or closed?

Is there an outdoor entrance to the basement?

Is there a drainage system in the basement? Specify types. Is it gravity or pump?

What material is the floor?

Concrete _____ Other _____
Earthen _____
Floor Covering Tile _____
Wood _____
Carpet _____ Synthetic _____ Natural Fiber _____
Padding under rug type _____
Other _____

a. What material is the wall?

Cement block _____ Concrete _____ Other _____

b. Wall covering: Ceramic tile _____
Wood panelling _____
Wallpaper _____
Stucco _____
Painted _____
Stone _____
Brick _____
Other _____ Describe.

Are there any furnishings? Specify all types.

Metallic _____ Softwood _____ Plastic upholster _____

Wrought iron w/baked enamel finish _____ Hardwood _____

Synthetic upholstered _____ Leather _____

Natural fabric upholstered _____ Sponge rubber _____

If crawl space:

Is it vented? Yes _____ No _____

Access to rest of house is by:

By Door _____ Always open _____ No access _____

Approximate area _____ sq. ft.

How far below ground is the floor? _____

What material are the walls:

concrete _____
cement block _____
other _____

What material is the floor?

soil _____
gravel _____
gravel on plastic film _____
concrete _____
other _____

- e. Is there a workshop, hobby or craft area in the residence?

How often is it used?

Where is it located?

Type of craft or hobby?

Photography	_____	Stained glass	_____
Dark room	_____	fabrication	_____
Pottery	_____	Jewelry making	_____
Ceramics	_____	Etching	_____
Sculpting	_____	Lithography	_____
Painting	_____	Silk screening	_____
Electronic Work	_____	Woodworking	_____
General repair	_____	Furniture	_____
Other	_____	Refinishing	_____
		Plastics molding	_____

What types of materials are used and/or stored here (brand names and type of products)?

- f. Kitchen

<u>Appliance</u>	<u>Type</u> <u>(gas or electric)</u>	<u>Model,</u> <u>Make & Year</u>	<u>General</u> <u>Condition</u>
------------------	---	---	------------------------------------

Refrigerator
Range
Oven
Freezer
Microwave Oven

Is the oven and range vented to the outside?

Is ventilation working?

Is the system vented to the outside or recirculated back into the kitchen?

Is the oven self-cleaning?

If not, what brand of oven cleaner do you use; how often is it used, and where is it stored?

What small appliances are there in the kitchen (make, model, year)?

g. Bathrooms (answer for each bathroom if more than one)?

Is there a ventilation system?

Is room freshener used frequently?

Brand?

Please list the items in your medicine cabinets?

What material is the tub, shower stall and sink?

Fiberglass _____
Ceramic _____
Porcelain _____
Other _____

h. Rooms 1 2 3 4 5 6 7 8 9
 Kitchen

1. Size of room:

2. Number of windows:

3. Draperies or curtains:

Cotton _____
Linen _____
Silk _____
Synthetic _____
Fiberglass _____

Are they lined? Yes _____ No _____

Venetian Blinds

Other

4. Cabinets and Counters:

Solid wood _____
Wood Veneer _____
Formica _____
Other _____

5. Floor Coverings:

Tile _____
Wood _____
Carpet _____
 Synthetic _____
 Natural fiber _____
 Wall to Wall, or area padding (type) _____
Have floors recently been refinished or
replaced? Explain.

6. Wall Coverings:

Ceramic tile _____
Brick _____
Stone _____
Wood Panelling _____
Wallpaper _____
Paint _____
Stucco _____
Other _____

7. Ceiling

Painted _____
Stucco _____
Dropped _____
Other _____

If drop, what is above panels?

8. Lighting

Fluorescent _____
Incandescent _____
Number of lights _____

How are they mounted?

Surface
Suspended
Recessed

Are there skylights?

9. Type of furnishings (check all that apply)?

Softwood _____
Hardwood _____
Feather Stuffed _____
Sponge Rubber _____
Plastic Upholstered _____
Synthetic Upholstered _____
Natural Fiber Upholstered _____
Leather _____
Metallic with enamel finish _____
Wrought iron _____
New furnishings? Explain _____
Televisions _____
Brand _____ Model _____ Year _____

10. Plants in room?

Chemicals used to maintain

Method of application

11. Consumer products used to clean?

12. Consumer products stored here?

13. Have any draperies, furniture coverings or carpets been dry cleaned recently?

14. Is there any additional information in this room that might be important?

i. Additional Information

1. Is there any noticeable, regularly occurring odors in this residence?

Describe where and with what frequency odors occur.

Describe type of odor as best as you can?

2. Is there any noticable water vapor, condensation in this residence? When? Where?

3. Do you have a washing maching and/or dryer?

Where?

Is the dryer vented to the outside?

4. Any home office equipment?

Typewriters, home copiers, home computer?

J. CLIMATOLOGY AND METEOROLOGY

1. Average temperature of area:

Summer _____
Fall _____
Winter _____
Spring _____

2. Average annual rainfall _____

3. Average annual snowfall _____

4. Average Daylight:

Summer
Fall
Winter
Spring

5. (a) Predominant wind direction
(b) Predominant wind speed

6. Inversion Frequency

NEW YORK STATE DEPARTMENT OF HEALTH
CANISTER AIR COLLECTION
FIELD DATA FORM

SITE INFORMATION

Location _____
Sampler # _____
Sampler's Initials _____

CANISTER INFORMATION

SIDE 1

SIDE 2

Canister #	_____	Canister #	_____
Canister Install Date	_____	Canister Install Date	_____
Collection Date	_____	Collection Date	_____
Initial Vacuum	_____	Initial Vacuum	_____
Final Vacuum	_____	Final Vacuum	_____
Valve Open	0	Valve Open	0

TIMER PROGRAM INFORMATION

Program Start	_____	Program Start	_____
Program Stop	_____	Program Stop	_____
Program Verification	0	Program Verification	0
Elapsed Time:	START _____	STOP	_____

FLOW CONTROLLER INFORMATION

Initial Zero Reading _____
Flow Dial Reading & _____

TEMPERATURE INFORMATION

Max. Temperature _____ Min. Temperature _____

SAMPLE TYPE

Field Sample 0 Field Duplicate 0 Trip Blank 0

COMMENTS

NEW YORK STATE DEPARTMENT OF HEALTH
BUREAU OF TOXIC SUBSTANCE ASSESSMENT
INDOOR AIR QUALITY RESIDENTIAL QUESTIONNAIRE

Date Prepared:
Prepared By:
Title:

Complete the following questionnaire for each household sampled:

A. GENERAL INFORMATION

(1) a. Head of Household: Name: _____

Address: _____

City: _____

County: _____

Home Phone No.: _____

Business Phone No.: _____

b. How many years have you resided at this address? _____

(2) Owner (If different than above)

Name: _____

Address: _____

City: _____

Phone No.: _____

B. DAILY ACTIVITY LOG FOR THE 24-HOUR PERIOD PRIOR TO SAMPLING

Answer the following for the 24-hour period just prior to sampling:

Date:

1. Did you cook breakfast?
Time?
2. Did you cook lunch?
Time?
3. Did you cook dinner?
Time?
4. Did you cook or bake anything special which add cooking time?
Time?
5. Did you turn on the kitchen ventilation fan while cooking? How long?
6. Did you use any chemical cleaning agents? If yes, which room(s) did you clean? State date, time and type(s) of cleaning materials used in each room.

7. Do you smoke? Did you have any guests that smoked? What type of smoking (cigarette, cigar, pipe, etc.). Date, time and room in which they smoked?

8. Was a spray or solid air freshener used in the house? What brand? Date, time and room in which it was used?

9. Did you open any windows? In which rooms did you open the windows? Between what hours were the windows open?

10. Did you vacuum? What brand of vacuum cleaner did you use? Date, time and time spent vacuuming each room?

11. Did you use a fireplace? When?

12. If you have an attached garage, was a car in the garage? Was it running (driven in or out) during the day?

13. What personal toiletries were used in your home?

14. Did you use the washing machine or dishwasher?

15. How many individuals took showers and what the approximate length of each.

16. Did you participate in any hobbies that require solvents?

17. Was anything in the house painted during the last 24 hours? In what room?

18. Was your general heating system used? How many hours?

19. Was a kerosene heater operated? For how long?

20. Has any construction or handy work been done in the home that required wallboarding, installing carpets, etc.? If yes, please explain.

21. Did you have any clothes dry-cleaned within the past 24 hours?

APPENDIX H

Key to Contaminants by Number

1	chloromethane
2	dichloromethane
3	hexane
4	chloroform
5	1,1,1-trichloroethane
6	carbon tetrachloride
7	benzene
8	trichloroethylene
9	toluene
10	tetrachloroethylene
11	ethylbenzene
12	m,p-xylene
13	o-xylene

#11710079

APPENDIX I

Quality Assurance of Indoor Air Data

1. VOCs

The NYSDOH indoor air and outdoor air VOC data meet the QA objectives for the project; they are included in the project data base

2. Formaldehyde

Formaldehyde sampling conducted as part of the indoor air portion of the study utilized a new samplers. Inaccurate timers, lack of an effective flow regulation mechanism, and reported problems with heat generation resulted in QA problems. Although steps were taken to work with the inherent design flaws of the system, they could not correct completely the problems encountered. Thus, mistiming, changing flow rates, and thermal shutoff or shutoff by individuals living in the sampled homes who were concerned about the heat buildup in these units, were possible.

QA information for the indoor air portion of the project was obtained by comparing the two consecutive 12-hour samples that were taken, with a collocated 24-hour sample. Since formaldehyde concentration is computed based on total sampling flow rate, the formaldehyde concentration of the average of the two 12-hour samples should be equal to the 24-hour sample concentration. Results of this analysis for all 21 sample sets taken in the study, with the exclusion of one outlier, showed an average percent difference of 46% between the formaldehyde concentration of the average of the two 12-hour samples and the formaldehyde concentration of the collocated 24 hour sample. The range of percent differences was between 2.3% to 215%.

EPA/AREAL provided a review of EPA's national formaldehyde field sampling programs. EPA/AREAL has shown that variability in collocated sampling data is most often attributed to out-of-control sampling equipment. As a result of the technical problems associated with the formaldehyde samplers, the collocated sampling information obtained in the indoor air portion of the study, and EPA/AREAL's data on NSI's capabilities, the data obtained with the samplers developed for the indoor air monitoring portion of the study were excluded from the project data base.

3. Radon

Radon sampling was conducted by NYSDOH for the indoor air monitoring portion of the project. Analysis of samples was conducted under the auspices of EPA-Las Vegas.

The EPA-Las Vegas QA data for the National Ambient Radon Study were accepted as a surrogate for QA data for the SI/NJ UATAP radon samples, since EPA-Las Vegas (1) provided the same sampling equipment for both projects; (2) analyzed the radon samples for both projects utilizing the same procedures, methods, and personnel; and (3) performed the services outlined in #1 and #2 over the same time periods. Because of these circumstances, the SI/NJ UATAP radon samples could be considered a subset of the radon samples provided and analyzed by EPA-Las Vegas for the National Ambient Radon Study.

The QA data provided for the National Radon Study show that, in quarterly comparisons over the period of one year, the radon devices of the type used in the SI/NJ UATAP were within $\pm 25\%$ of a certified continuous radon gas monitor operated at the Las Vegas Outdoor Radon Monitoring Station. Radon concentrations at this site were typically slightly above or just below the minimum detectable amount, defined as three standard deviations above the average measurement of a field blank.

Seven-day tests were conducted at the EPA-Las Vegas Underground Radon Chamber on a quarterly basis for a year. The results showed that the radon devices of the type used in the SI/NJ UATAP were within $\pm 12\%$ of the actual radon concentration.

Although duplicate samples were not taken for the SI/NJ UATAP radon data, the results for the National Ambient Radon Study show that the annual average ratio for duplicate samples was 0.97.

In view of these QA data as well as other information contained in the report, the radon data were included in the project data base.