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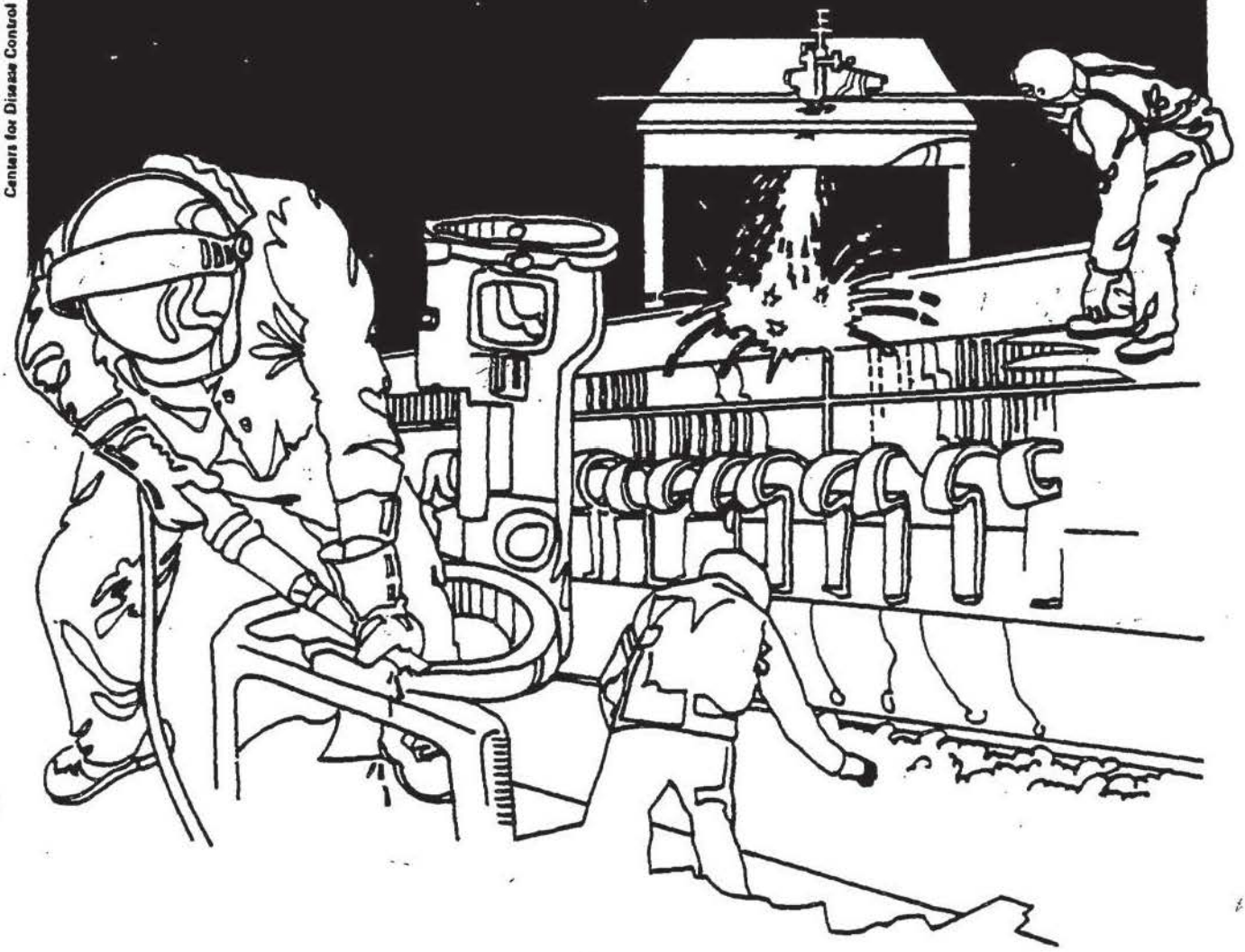

Health Hazard Evaluation Report

HETA 85-454-1695
MID VALLEY SCHOOL
THROOP, PENNSYLVANIA

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HETA 85-454-1695
May 1986
MID VALLEY SCHOOL
THROOP, PENNSYLVANIA

NIOSH INVESTIGATOR:
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I. SUMMARY

In July 1985, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation from Mid Valley High School, Throop, Pennsylvania, to evaluate air-formaldehyde levels in the school building. Sources of formaldehyde in the 5-year old building include phenol polymethylol urea foam insulation, acoustical ceiling insulation, carpeting, and pressed wood products used in furniture and cabinets.

On August 15-16, 1985, a NIOSH investigator collected 21 air samples for formaldehyde, concentrating on those classrooms shown to have the highest formaldehyde levels from monitoring conducted earlier by environmental consultants of the school board. On January 15, 1986, five more air samples were collected in those rooms to determine what effect the colder weather had on formaldehyde levels.

The school board consultants had found formaldehyde concentrations ranging up to 0.28 parts per million (ppm) in closed classrooms with no ventilation during the hottest days of summer. Classrooms with a south-facing outer wall appeared to have the highest levels of formaldehyde. However, there was little indication that formaldehyde levels would exceed 0.1 ppm in these rooms during normal operations. With the individual classroom heating, ventilating, and air conditioning (HVAC) units operating normally, August formaldehyde samples taken by NIOSH staff in these rooms ranged from 0.05 to 0.09 ppm with a mean of 0.06 ppm. In January, formaldehyde samples in these rooms ranged from 0.03 to 0.06 ppm with a mean of 0.04 ppm.

These levels are well within the range of typical residential formaldehyde exposure (conventional homes without urea-formaldehyde foam insulation or particle board floors). The fact that formaldehyde is found in so many home products, appliances, furnishings and construction materials has prompted several agencies to set standards or guidelines for residential formaldehyde exposure. The American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) has recommended, based on personal comfort, that exposure to formaldehyde be limited to 0.1 ppm. This guideline also has been adopted by NASA, and the Federal governments of Canada, West Germany, and the United Kingdom.

The Mid Valley classroom HVAC units are designed to handle 1250 cubic feet per minute (cfm) of air which contains a minimum of 20% fresh air. Assuming an average class size of 25, this would ensure a minimum rate of 10 cfm of fresh air per person. ASHRAE has a recommended guideline of 5 cfm fresh air per person (in no smoking areas), which is sufficient to ensure that most typical indoor air contaminants are kept below levels that may cause complaints of discomfort or adverse health effects.

Based on the data collected in this investigation, it was concluded that there was no hazard due to exposure to formaldehyde. It was recommended that the classroom HVAC units be maintained and operated as they were designed to ensure adequate indoor air quality.

KEYWORDS: SIC 8211, Formaldehyde, Indoor Air Quality

II. INTRODUCTION

In July 1985, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation at the Mid Valley School District Secondary Center, Throop, Pennsylvania. The request was submitted by school board members who were concerned about possible formaldehyde exposures among students and employees in the school building.

III. BACKGROUND

About 700 students attend school in the 5-year old building. Problems with odor complaints began to occur in March 1985. The odor was found to be caused by electrical components being heated by faulty terminal connections on fluorescent light bulbs. The problem was solved by replacing the faulty equipment. In the meantime, however, environmental consultants, who had been hired to investigate the original odors, collected air samples for formaldehyde and reported air concentrations ranging up to 0.28 parts per million (ppm). Thereafter, attention was focused on health problems related to exposure to formaldehyde.

One of the consultants expressed the opinion that formaldehyde levels "should not exceed 0.03 ppm", because "teachers, students, office personnel, etc. cannot function to their potential under such circumstances". This led to recommendations such as tearing down the outer walls and removing the foam insulation, or since that was not very feasible, to simply abandon the modern facility.

IV. METHODS

NIOSH investigators conducted an initial visit on August 5, 1985. The facility was inspected and previous work conducted by environmental consultants was reviewed. A problem with the ventilation system was found to cause restricted amounts of fresh air to be supplied to some classrooms. After the problems with the ventilation system were corrected, 21 air samples for formaldehyde were collected on August 15-16, 1985.

Five classrooms were chosen for air sampling because that they were found to have the highest formaldehyde air levels during previous sampling. The rooms were sampled under two different conditions. On August 15, samples were collected with the individual heating, ventilating, and air conditioning (HVAC) units running in each of the rooms. These units were turned off overnight and left off during air sampling conducted on August 16. Also, two air samples were collected outdoors on August 15.

Five more air samples were collected at the school on January 15, 1986, to determine what effect the colder weather had on formaldehyde levels.

All air samples were drawn at a flowrate of 1.0 liters per minute through midget impingers containing a 1% sodium bisulfite solution. Analysis was by visible absorption spectroscopy according to NIOSH Method 3500.[1] The environmental consultants hired by the school also used this method.

V. EVALUATION CRITERIA

A. Building-Related Illness Episodes

Building-related illness episodes have been reported more frequently in recent years as buildings have been made more air-tight in order to conserve energy and to reduce air conditioning expenses. Modern high-rise office buildings are constructed primarily of steel, glass, and concrete, with large windows that cannot be opened, thus making the building totally dependent on mechanical systems for air conditioning. Contaminants may be present in make-up air or may be introduced from indoor activities, furnishings, building materials, surface coatings, and air handling systems and treatment components. Symptoms often reported are eye, nose, and throat irritation, headache, fatigue, and sinus congestion. Occasionally, upper respiratory irritation and skin rashes are reported. In some cases, the cause of the symptoms has been ascribed to an airborne contaminant, such as formaldehyde, tobacco smoke, or insulation particles, but most commonly a single cause cannot be pinpointed.

Imbalance or malfunction of the air conditioning system is commonly identified, and in the absence of other theories of causation, illnesses are usually attributed to inadequate ventilation, heating/cooling, or humidification.

B. Formaldehyde

Formaldehyde and other aldehydes may be released from foam plastics, carbonless paper, particle board, plywood, and textile fabrics. Formaldehyde is an irritant to the eyes, nose, mouth, and throat. Recently, formaldehyde vapor has been found to cause a rare form of nasal cancer in rats. These results have prompted NIOSH to recommend that formaldehyde be handled as a potential occupational carcinogen. An estimate of the cancer risk to workers exposed to formaldehyde levels at or below the current 3 ppm standard has not yet been determined. In the interim NIOSH recommends that workplace exposures be reduced to the lowest feasible limit.

The fact that formaldehyde is found in so many home products, appliances, furnishings and construction materials has prompted several agencies to set standards or guidelines for residential formaldehyde exposure. (ASHRAE) has recommended, based on personal comfort, that exposure to formaldehyde be limited to 0.1 ppm. This guideline has also been adopted by NASA, and the Federal governments of Canada, West Germany, and the United Kingdom.

Table I summarizes data from many studies of formaldehyde levels in homes in different parts of the United States, Canada, and the United Kingdom. Mobile homes, due to the large amount of pressed wood products in their construction, have the highest formaldehyde concentrations. A mean of 0.4 ppm has been found in most of the studies conducted in mobile homes. Most other types of homes have average formaldehyde levels less than 0.1 ppm. Interestingly, mean formaldehyde levels in homes with foam insulation are only slightly higher than levels in homes without foam insulation, although a higher percentage of foamed houses do have formaldehyde levels exceeding 0.1 ppm. The older (>15 years) conventional homes have a mean formaldehyde level of 0.03 ppm and they represent the class of dwellings with the lowest levels of formaldehyde.[2]

C. Ventilation Evaluation Criteria

Neither NIOSH nor OSHA has developed ventilation criteria for general offices. Criteria often used by design engineers are the guidelines published by ASHRAE.

Until recently, the ASHRAE Ventilation Standard 62-73 (1973) was utilized, but recommendations were based on studies performed before the more modern, air-tight office buildings became common. These older buildings permitted more air infiltration through leaks in cracks and interstices, around windows and doors, and through floors and walls. Modern office buildings are usually much more air-tight and permit less air infiltration. Due to the reduced infiltration, ASHRAE questioned whether the 1973 minimum ventilation values assure adequate outdoor air supply in modern, air-tight buildings.

Subsequently, ASHRAE has revised its standard and has published the new standard, ASHRAE 62-1981, "Ventilation for Acceptable Indoor Air Quality." The new standard is based on an occupant density of 7 persons per 1000 ft^2 of floor area, and recommends higher ventilation rates for areas where smoking is permitted. The new ASHRAE standard states that indoor air quality for "General Offices" shall be considered acceptable if the supply of outdoor

air is sufficient to reduce carbon dioxide to less than 2500 ppm and to control contaminants, such as various gases, vapors, microorganisms, smoke, and other particulate matter, so that concentrations known to impair health or cause discomfort to occupants are not exceeded. However, the threshold levels for health effects from these exposures are poorly documented. For "General Offices" where smoking is not permitted, the rate recommended under the new standard is 5 cfm of outdoor air per person.

Higher ventilation rates are recommended for spaces where smoking is permitted because tobacco smoke is one of the most difficult contaminants to control at the source. When smoking is allowed, the amount of outdoor air provided should be 20 cfm per person. Areas that are nonsmoking areas may be supplied at the lower rate (5 cfm/person), provided that the air is not recirculated from, or otherwise enters from, the smoking areas[3].

The ASHRAE Standard 62-1981 also provides ventilation requirement guidelines for a wide variety of commercial, institutional, residential, and industrial facilities and should be consulted for application to the specific situation under evaluation.

VI. RESULTS AND DISCUSSION

The major source of formaldehyde emission in the school is probably the Tripolymer® #105 foam insulation. This is a phenol polymethylol urea polymer that was sprayed into the masonary cavities of the outer walls. The manufacturer claims that this product contains much less free formaldehyde than that found in urea-formaldehyde foam insulation.[4] Other formaldehyde sources in the school could include pressed wood products used in furniture and cabinets, acoustical ceiling insulation, carpeting, and duplicating machines.

With the HVAC units running, August formaldehyde levels ranged from 0.02 to 0.09 ppm with a mean of 0.05 ppm (Table II). The HVAC units are designed to handle 1250 cfm of air which contains a minimum of 20% fresh air. However, the static pressure relief vents must be open in order to achieve the designed amount of fresh iar. These vents were not found to be operating properly during our initial visit. The vent louvres were heavily weighted or even clamped shut in some cases. This may have been done as an energy-saving measure. Conversations with a representative of the HVAC manufacturer indicated that an estimated 6 to 10% fresh air would be supplied to rooms with closed relief vents.

The vents were adjusted to operate properly during the August 15 air sampling, and slight lowering of formaldehyde levels was noted. In the three rooms where the most data have been collected, Typing A, Typing B, and Office Practice, formaldehyde levels ranged from 0.04 to 0.11 ppm with a mean of 0.07 ppm with restricted air relief vents (14 air samples collected by one of the contractors from March 30 to June 13, 1985). With relief vents open in these three rooms, the air sampling in August showed formaldehyde levels ranging from 0.05 to 0.06 ppm with a mean of 0.05 ppm.

The outdoor formaldehyde air level was 0.008 ppm (Table II).

Most studies on the effect of seasonal variations on residential formaldehyde exposure indicate that a majority of conventional homes will have a formaldehyde concentration exceeding 0.1 ppm on one or more days of the year. The highest levels usually occur during the hottest, most humid days of summer.[1] Likewise, the effect of heat appeared to be an important factor on formaldehyde levels at the Mid Valley School. The classrooms with higher formaldehyde levels are located on the south side of the school, where exposure to the sun is greater. The room with the highest formaldehyde levels, the Art Room, is located at the southwest corner of the school where solar exposure is greatest. With properly functioning ventilation the Art Room had formaldehyde levels ranging from 0.07 to 0.09 ppm on August 15, 1985. The outdoor temperature that day was 85-90°F during sampling.

On January 15, 1986, the classrooms Typing A, Typing B, and Office Practice all had a formaldehyde concentration of 0.03 ppm (Table III). The Art Room had formaldehyde levels ranging from 0.04 to 0.06 ppm. The outdoor temperature that day was 15-20°F during sampling.

VII. CONCLUSION

During normal operations with the HVACs running properly, formaldehyde exposure at the Mid Valley School is well within the range of typical residential formaldehyde exposure (i.e. similiar to conventional homes without urea-formaldehyde foam insulation or particle board floors). Formaldehyde levels are well within the ASHRAE guideline of 0.1 ppm, with the possible exception of the Art Room during the hottest days of summer when formaldehyde levels may reach 0.1 ppm.

The school can be roughly divided into three formaldehyde exposure gradients. (1) Depending on the weather, Art Room formaldehyde levels range from 0.04 to 0.09 ppm, which is comparable to that found in conventional homes less than 5 years old. (2) Classrooms with south-facing outer walls have formaldehyde levels ranging from 0.03 to 0.06 ppm, which is comparable to conventional homes 5 to 15 years old. (3) Formaldehyde levels throughout the rest of the school range up to 0.03 ppm, which is comparable to conventional homes greater than 15 years old.

VIII. RECOMMENDATION

The HVAC units should be maintained and operated as they were designed. Assuming an average class size of 25, this will ensure a minimum rate of 10 cfm of fresh air per person. This amount of fresh air is well above the ASHRAE guideline (5 cfm/person in no-smoking areas) and should ensure that most typical indoor air contaminants are kept below levels that may cause adverse health effects.

IX. REFERENCES

1. National Institute for Occupational Safety and Health. NIOSH manual of analytical methods. 3rd ed. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1984. (DHHS (NIOSH) publication no. 84-100).

2. Gammage R B, Hawthorne A R. "Current Status of Measurement Techniques and concentrations of Formaldehyde in Residences." Turoski V. Formaldehyde: analytical chemistry and toxicology. "Developed from a symposium sponsored by the Division of Environmental Chemistry at the 87th Meeting of the American Chemical Society, St. Louis, MIssouri, April 8-13, 1984."

3. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. ASHRAE standard 62-1981, ventilation for acceptable indoor air quality. Atlanta, Georgia: ASHRAC, 1981.

4. Letter from C. P. Chemical Company to the Consumer Product Safety Commission, "Regulatory Options on Urea Formaldehyde Foam Insulation", November 24, 1980.

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XI. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Publications Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. Mid Valley School
2. Pennsylvania House of Representatives
3. Senate of Pennsylvania
4. NIOSH, Region III
5. OSHA, Region III

TABLE I*

Reported Levels of Formaldehyde in the Indoor Air Classes of Private Residences

Type of Residence	No. of Residences	Formaldehyde (ppm) Range	Mean
U.S.homes without urea-formaldehyde foam insulation (UFFI)	41	0.01-0.1	0.03
U.S. homes with UFFI (complaint and noncomplaint)	636	0.01-3.4	0.12
U.S. mobile homes	431	0.01-3.5	0.38
Canadian houses without UFFI	383	(3% >0.1ppm)	0.036
Canadian houses with UFFI	1850	(10% >0.1ppm)	0.054
U.S. houses without UFFI and without particle board	17	-	0.025
U.S. houses with UFFI but without particle board subfloors	600	-	0.050
U.S. mobile homes	several hundred		0.12
U.K. buildings without UFFI	50	<0.02->0.3 (3% >0.1ppm)	0.047
U.K. buildings with UFFI	128	0.01->1 (7% >0.1ppm)	0.093
U.S. houses without UFFI	42	0.03-0.17	0.06
U.S. houses without UFFI	31	-	0.07
U.S. houses with UFFI	-	-	0.06
Mobile homes (Minnesota complaint)	100	0-3.0	0.4
Mobile homes (Wisconsin complaint)	-	0.02-4.2	0.9
Mobile homes (Wisconsin)	65	<0.10-3.68	0.47
Mobile homes (Washington complaint)	-	0-1.77	0.1-0.44

continued

TABLE I*
(continued)

Reported Levels of Formaldehyde in the Indoor Air Classes of Private Residences

Type of Residence	No. of Residences	Formaldehyde (ppm) Range	Mean
U.S. mobile homes			
Never occupied	260	-	0.86
Older, occupied			0.25
East Tennessee homes	40	<0.02-0.4	0.06
Age 0-5 years	18	-	0.08
Age 5-15 years	11	-	0.04
Age >15 years	11	-	0.03
Conventional California, Colorado, and S.Dakota homes	64	0.02-0.11	0.05
Specialized U.S. housing	52	0.03-0.3	0.1

*Gammage R.B., Hawthorne A.R. "Current Status of Measurement Techniques and concentrations of Formaldehyde in Residences." Turoski V. Formaldehyde: analytical chemistry and toxicology. Page 125. "Developed from a symposium sponsored by the Division of Environmental Chemistry at the 187th Meeting of the American Chemical Society, St. Louis, Missouri, April 8-13, 1984."

TABLE II

Formaldehyde Air Levels*

Mid Valley
Throop, Pennsylvania
HETA 85-454
August 15-16, 1985

LOCATION	SAMPLE DATE & TIME	Concentration (ppm)
Typing A	8/15** 945 - 1200	0.05
Typing A	8/15 945 - 1200	0.05
Typing A	8/16***826 - 1023	0.18
Typing A	8/16 826 - 1023	0.15
Typing B	8/15 - 950 - 1206	0.05
Typing B	8/15 - 950 - 1206	0.06
Typing B	8/16 - 830 - 1026	0.10
Typing B	8/16 830 - 1026	0.11
Office Practice	8/15 948 - 1212	0.06
Office Practice	8/16 828 - 1031	0.11
Office Practice	8/16 828 - 1031	0.12
S-108	8/15 955 - 1220	0.03
S-108	8/15 955 - 1220	0.02
S-108	8/16 832 - 1038	0.05
S-108	8/16 832 - 1038	0.03
Art Room - east half	8/15 1000 - 1227	0.09
Art Room - west half	8/15 1000 - 1227	0.07
Art Room - east half	8/16 834 - 1042	0.18
Art Room - west half	8/16 834 - 1042	0.14
Outdoors	8/15 953 - 1615	0.008
Outdoors	8/15 953 - 1615	0.008

*NIOSH Method 3500 (previously P & CAM 125). National Institute for Occupational Safety and Health. NIOSH Manual of Analytical Methods. 3rd ed. Cincinnati, Ohio, 1984 (DHHS (NIOSH) publication no. 84-100.

**8/15 - HVAC systems operating

***8/16 - HVAC systems not operating

TABLE III

Formaldehyde Air Levels

Mid Valley School
Throop, Pennsylvania
HETA 85-454
January 15, 1986

LOCATION	SAMPLE TIME	Concentration (ppm)
Typing A	917 - 1139	0.03
Typing B	920 - 1140	0.03
Office Practice	919 - 1142	0.03
Art Room - east half	923 - 1136	0.06
Art Room - west half	923 - 1136	0.04

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