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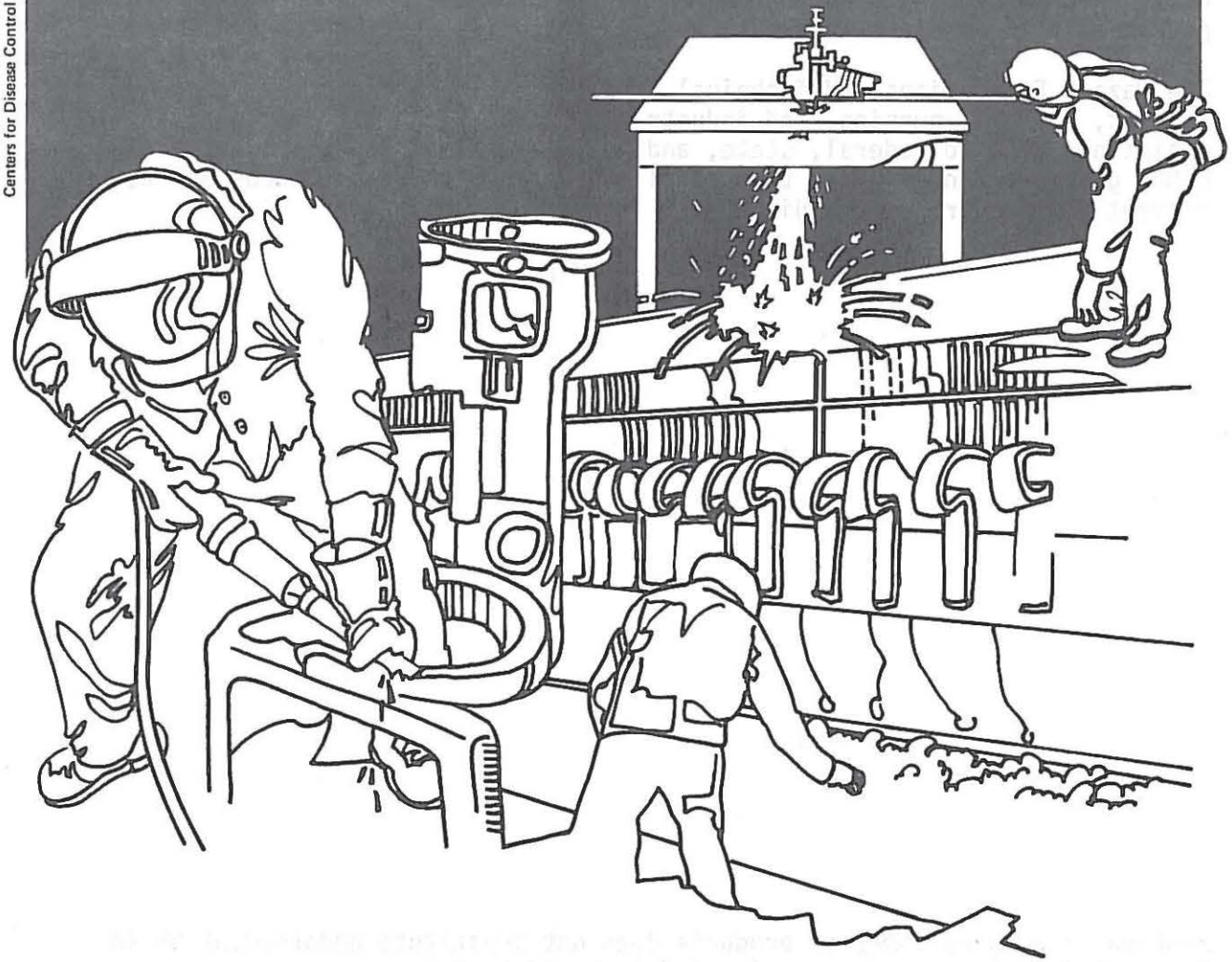

Health Hazard Evaluation Report

HHE 80-185-842
DEPARTMENT OF MUNICIPAL RAILWAY
WOODS DIVISION
SAN FRANCISCO, CALIFORNIA

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.

HHE 80-185-842
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DEPARTMENT OF MUNICIPAL
RAILWAY (WOODS DIVISION)
SAN FRANCISCO, CALIFORNIA

NIOSH INVESTIGATORS:
Pierre L. Belanger, I.H.
Molly J. Coye, M.D., M.P.H.

I. SUMMARY

On July 3, 1980 the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation from a representative of the Civil Service Association, Local 400. The requestor was concerned that storekeepers and mechanics working at the Department of Municipal Railway (Woods Division) may be exposed to toxic concentrations of diesel exhaust fumes. The employees complained of headaches, respiratory and eye irritation.

NIOSH conducted an initial environmental survey on July 23, 1980 and a follow-up environmental/medical survey on September 23, 1980. Area air sampling was conducted on the first and second floors of the repair terminal for sulfur dioxide, formaldehyde, nitrogen dioxide, and carbon monoxide using direct reading colorimetric detector tubes. No sulfur dioxide, formaldehyde or nitrogen dioxide gas was detected. Carbon monoxide concentrations ranged from below the limits of detection to 7 ppm (parts of a vapor or gas per million parts of contaminated air). These concentrations were below the NIOSH recommended criteria (35 ppm). Three general area air samples were collected for total particulate. The concentrations measured were 0.07, 0.08, 0.13 mg/M^3 (milligrams of particulate per cubic meter of air). All of these concentrations were well below the California-Occupational Safety and Health Administration (CAL-OSHA) standard.

Informal medical interviews were conducted with twelve day shift employees who worked in the administrative offices, storekeepers room (parts department) and maintenance areas. Questions were asked regarding work history and recent symptoms of headache, eye, nose and throat and/or lung irritation. Workers were also asked about possible exposures to diesel fumes and smoke. Complaints of eye and upper respiratory irritation, dizziness, headaches and odor irritation consistent with diesel exhaust exposures were reported, particularly in the storekeeping, brake relining and injector cleaning rooms where fumes are concentrated.

Based on the environmental air samples collected during the dates of this survey, overexposures to sulfur dioxide, formaldehyde, nitrogen dioxide, carbon monoxide and total particulate did not exist. However the symptoms reported and/or experienced by the investigators and employees are consistent with diesel fume exposure. Recommendations have been included in the body of the report to reduce diesel exhaust fume exposure.

KEYWORDS: SIC 4172 (Maintenance and Service Facilities for Motor Vehicle Passenger Transportation), diesel fumes, sulfur dioxide, formaldehyde, nitrogen dioxide, carbon monoxide.

II. INTRODUCTION

On July 3, 1980 the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation from an authorized union representative of the Civil Service Association, Local 400, at San Francisco, California. The requestor was concerned that storekeepers and mechanics working at the Department of Municipal Railway (Woods Division) may be exposed to toxic concentrations of diesel exhaust fumes. Complaints of headaches, respiratory and eye irritation were reported.

NIOSH conducted an initial environmental survey on July 23, 1980. The NIOSH investigators experienced eye irritation and smelled strong diesel odors when they walked through the storekeepers' work area (first floor) and the senior storekeepers office (second floor). A follow-up environmental/medical survey was conducted September 23, 1980 to evaluate the storekeepers' exposures to sulfur dioxide, formaldehyde, nitrogen dioxide, carbon monoxide and total particulate.

On October 8, 1980, NIOSH conducted a workers' education program to inform the employees about the potential health hazards associated with diesel exhaust fume exposures.

III. BACKGROUND

The Department of Municipal Railway (Woods Division) operates a maintenance and servicing terminal. The maintenance facility, which is about 4 1/2 years old, is a three-story structure which includes the following: the first floor consists of light and heavy maintenance, storekeeping (parts department) and support maintenance (machine shop, welding shop, engine rebuild, etc.). The second floor houses the senior storekeepers office and warehouse. The third floor consists of administrative offices.

The storekeeping area is located between the light and heavy maintenance departments. Five storekeepers work first shift (7:00 - 3:30) and two work second shift (3:00 - 11:30). Four employees work day shift in the senior storekeeper's office directly above the storekeepers room.

The light and heavy maintenance departments each have 12 bays with local exhaust ventilation at each station. Buses are backed into the maintenance stalls and a flexible exhaust duct is connected to the bus exhaust pipe while the buses are run indoors. Two of the three types of buses do not have exhaust pipes which are close enough to the ground to connect the flexible exhaust duct; consequently, these buses are brought in forward rather than backed into the stalls.

IV. HAZARD EVALUATION DESIGN

A. Evaluation Criteria and Health Effects

Occupational exposure criteria have been developed to evaluate worker's exposure to chemical substances. Two sources of criteria were used to assess the workroom concentrations: (1) NIOSH Criteria for a Recommended Standard, and (2) California Occupational Safety and Health Administration (CAL-OSHA) Standards. These values represent concentrations to which it is believed that nearly all workers may be exposed for an 8-hour day, 40-hour work week throughout a working lifetime without experiencing adverse health effects.

TABLE A

Substance	Time Weighted Average (TWA)[a]	Ceiling Value
Sulfur Dioxide (NIOSH)	0.5 ppm[b]	-
Sulfur Dioxide (CAL-OSHA)	5.0 ppm	-
Formaldehyde (NIOSH)	Lowest feasible limit	-
Formaldehyde (CAL-OSHA)	2	2
Nitrogen Dioxide (NIOSH)	-	-
Nitrogen Dioxide (CAL-OSHA)	5	5
Carbon Monoxide (NIOSH)	35 ppm	200
Carbon Monoxide (CAL-OSHA)	50 ppm	400
Total Particulate (NIOSH)	-	-
Total Particulate (CAL-OSHA)	10 mg/m^3[c]	-

(a) TWA - NIOSH exposure is based on a work day up to 10 hours long, whereas CAL-OSHA Standard is based on an 8-hour work day.

(b) ppm - Parts of a vapor or gas per million parts of contaminated air by volume.

(c) mg/m^3 - Milligrams of a substance per cubic meter of air.

B. Materials and Methods

1. Environmental

Area air sampling for sulfur dioxide, formaldehyde, nitrogen dioxide and carbon monoxide were collected from storekeeping, the senior storekeeper's office, and in the light maintenance department. The samples were collected using direct reading Drager® gas detector tubes (Table I).

Three samples were collected for total particulate weight using a MSA® vacuum pump operating at 1.5 liters per minute, and a two piece, 37-millimeter, closed-face cassette and filter (M-5). The total particulate weight of samples were determined by weighing the samples on an electro-balance.

2. Medical Monitoring Design and Methods

On Tuesday September 23, 1980, informal medical interviews were conducted with twelve day shift workers in the administrative offices, parts department and maintenance areas. Questions were asked regarding history or recent symptoms of headache, eye, nose, throat and/or lung irritation. Workers also were asked about what concerns they had related to diesel fumes and smoke.

C. Toxicological Effects

Diesel Exhaust

Diesel exhaust contains several thousand different chemicals and materials, only some of which have been analyzed. A few of these chemicals are most likely to cause immediate irritation to people who breath them in while working.

Short Term Effects

(1) Formaldehydes and other aldehydes:

Formaldehyde is best known for its use by embalmers and morticians to preserve dead bodies and tissues. It has a sharp odor which can be smelled at very low levels (less than 1 part in a million parts of air, or 1 ppm). At levels between 1-5 ppm, formaldehyde makes the eyes water and sting. At 20 ppm, many people notice singing or prickling in the throat and nose. Low levels -- 0.3 to 2.7 ppm -- have also been found to disturb sleep and to be irritating to a smaller number of people.(1)

Other aldehydes -- such as acrolein -- also cause irritation to the nose, throat, eyes and lungs at even lower levels of air concentrations.

(2) Nitrogren dioxide (NO_2)

NO_2 is well known as the gas which makes smog over large cities like Los Angeles turn yellow or yellow brown. This gas also causes irritation of the nose, throat, and lungs at low levels (5 ppm). It may cause cough and phelgm (mucous) which persist at these levels. At higher levels, 50 ppm or more, NO_2 will cause serious swelling in the lungs, and in some cases permanent lung damage.(2)

(3) Carbon monoxide (CO)

CO prevents the blood from carrying oxygen from the lungs to the tissues. There are small amounts of CO is most smokes (cigarettes, auto exhaust, etc.). CO causes headache and drowsiness at low levels. Diesel fumes contain smaller amounts of CO than gasoline combustion fumes, and CO is considered generally a less serious potential problem in diesel fumes.(2)

(4) Soot (particulates)

Diesel engines produce 30-50 times as much smoke particles as gasoline engines. This smoke is easily breathed in and becomes trapped in the lungs. It causes cough and phlegm. (2)

(5) Sulfur dioxide (SO_2)

SO_2 causes symptoms of irritation similar to those caused by NO_2 and formaldehydes.

Long Term Effects

(1) Polycyclic aromatic hydrocarbons (PAH's): these are organic chemicals found in very small quantitites in diesel fumes. Several of these chemicals are known to cause cancer in laboratory animals. Whether or not they cause

cancer in humans is not clear at this time, but is a strong possibility that cannot be ignored. (2)

(2) Smoke particles (soot): Just like cigarette smoke, these particles settle in the lung. Diesel soot is largely made up of carbon black particles. Although the long term effects of breathing diesel smoke are not known, it is known that workers in the carbon black industry suffer from emphysema, chronic bronchitis, and a lung disease similar to coal miner's lung (pneumoconiosis). (3)

In addition, diesel soot particles have been shown to have PAH's on their surface, and it has been suggested that soot particles carry these suspected carcinogens deep into the lungs.

(3) NO_2 and SO_2 and formaldehyde: years of exposure to these irritants may cause or speed up the development of lung diseases such as those described above. Formaldehyde has been reported to cause nasal cancer in experimental animals. (4,7)

Asbestos

Asbestos fibers are well known for their role in causing asbestosis, a lung disease involving fibrosis and tightening of the lungs. This disease develops slowly, usually waiting 20-30 years after the first exposure to asbestos to make itself known. By that time, the damage has already been done -- the affected person has shortness of breath, the lungs don't expand well, and breathlessness gets worse as they get older.

Asbestos fibers breathed from the air also represent an increased risk of developing lung cancer, whether you smoke or not. Smoking makes this increased risk even greater though -- smokers working with asbestos suffer cancer at a rate of 55 times higher than the rate of cancer for non-smoking persons.

Mesothelioma is a rare form of cancer almost never seen in the general population. Mesothelioma is seen fairly often in persons who work with asbestos of their family members and persons who live near asbestos plants. This form of cancer causes 5-7% of all deaths of asbestos workers. Is is rapidly fatal cancer of the tissue lining the lungs. (5)

Asbestos-related disease can be caused by very brief exposures to asbestos, ranging from 1 day to only a few weeks. Exposure can be (1) direct-working with asbestos in brake shops, for example, or (2) indirect-washing the contaminated clothes of a person working with asbestos (housewives, for example). NIOSH has found no safe level of exposure to air-borne asbestos. Therefore, it is important to minimize or avoid all exposure to asbestos.

There are several different types of asbestos fiber, but studies have shown that all of these cause disease at similar rates. Thus, asbestos used in brake-lining is just as dangerous to a person as asbestos in the mine itself.

The current asbestos standard in the U.S. is 2 million fibers per cubic meter, but NIOSH has recommended lowering this standard to 100,000 fibers per cubic meter. Even at this lower level though, asbestos-related disease may develop. (6)

V. RESULTS AND DISCUSSION

Environmental

No sulfur dioxide, formaldehyde or nitorgen dioxide was detected on any of the detector tubes. Carbon monoxide was detected at concentrations which ranged from below the limit of detection to 7 ppm. However, these concentrations were well below the NIOSH recommended criteria.

Three samples collected for total particulate were found to contain 0.07, 0.08 and 0.13 mg/m^3 which is far below the CAL-OSHA standard.

Although no excessive exposures were detected during the survey, the NIOSH investigators did experience eye irritation during the initial survey. Several factors appear to have contributed significantly to these periodic episodes of eye and respiratory irritation: (1) The periods of greatest irritation are reported to occur whenever the air is stagnant. (2) The lack of a local exhaust duct which is compatible to all the bus exhaust system aggravates the situation further since all diesel exhaust fumes are not being captured when buses are operated indoors. (3) The exhaust duct located in the third floor is approximately five to ten feet from the building make-up air duct, therefore, contaminated air is being recirculated. (4) The horizontal make-up air ducts located on the light maintenance side of the building become contaminated with diesel exhaust fumes from buses which are left idling in the yard subsequent to being serviced. It was reported that several buses may remain idling in this yard for up to twenty minutes prior to returning the buses to the lot.

Medical

Workers in the administrative offices, parts department, brake relining shop, injector cleaning room and both heavy and light maintenance areas complained of watering, stinging eyes occurring when diesel fumes and smoke are heaviest in the shop. Several of these persons also reported headaches, drowsiness, and odor annoyance associated with the fumes. Two persons noticed chest tightness and breathlessness, most remarkable when the fumes were heavy during hot, stagnant weather. One person complained of nausea related to the fumes. Persons working in the brake relining area complained of coughing up sputum which was black after working there during days when the diesel fumes were heavy. Smoking and non-smoking persons reported the above symptoms similarly.

Complaints were most common and severe in the storekeeping, brake relining room, and injector cleaning room. Workers observed that fumes accumulate in these areas for longer periods of time than in the maintenance area before being cleared away by air currents or the ventilation system. They also reported that the fumes caused greater health problems during hot, still weather.

Workers in the brake relining room stated concern about the long term health effects of diesel fumes and asbestos dust. Workers also expressed concern about exposure to caustic vapors involved in the engine cleaning room.

VI. CONCLUSIONS

Workers at the Muni repair shop reported symptoms of eye, nose, throat and lung irritation which are consistent with those reported in the medical literature for diesel fume exposure. These symptoms are not totally explained by smoking habits, and are reported to be aggravated by hot, stagnant air.

VII. RECOMMENDATIONS

1. Yearly spirometry tests of lung function should be provided for workers exposed to diesel fumes and caustic vapors in which both were reported to produce upper respiratory irritation.

2. As asbestos surveillance program which should include periodic environmental sampling should be provided to monitor the health effects of asbestos on personnel working in the brake relining area and employees changing wheels for drum grinding.

3. An educational program should be developed to inform workers about the hazardous materials present in their workplace, specifically diesel fumes caustic vapors, solvents and asbestos dust.

4. Ventilation should be provided under the brake drum grinding machines to remove asbestos dust at the point of production. In addition, the use of respirators needs to be started for workers changing wheels for drum grinding. A vacuum line is also needed to remove asbestos dust at this point.

5. A local exhaust duct which is compatible to the three types of bus exhaust ducts should be designed and utilized when buses are operated indoors.

6. Steps should be taken to assure that air exhausted on the third floor is not permitted to cross contaminate the make-up air units located nearby.

7. Buses which are serviced with fuel should be returned to the parking lot immediately as opposed to idling the buses outside of the light maintenance area to prevent diesel-fume contamination of the horizontal make-up air ducts.

VIII. REFERENCES

(1) Criteria for a Recommended Standard: Occupational Exposure to Formaldehyde, DHEW (NIOSH) Publication No. 77-126, Cincinnati, U.S. Department of Health Education and Welfare, PHS, NIOSH, 1977.

(2) Health Hazard Determination: White Pass and Yukon Railroad, DHEW (NIOSH) Publication No. 74-1-160, Cincinnati, U.S. Department of Health,Education, and Welfare, PHS, NIOSH, 1974.

(3) Criteria for a Recommended Standard: Occupational Exposure to Carbon Black, DHEW (NIOSH)Publication No. 78-204, Cincinnati, U.S. Department of Health, Education, and Welfare, PHS, NIOSH, 1978.

(4) Chemical Industry Institute of Toxicology, preliminary results of animal tests, as reported in Occupational Health & Safety Letter, April 8, 1980.

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(6) Workplace Exposure to Asbestos: Review and Recommendations, NIOSH internal memorandum, report of NIOSH-OSHA Asbestos Work Group, U.S. Dept of HEW and Department of Labor, April, 1980.

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IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared By:

Pierre L. Belanger
Industrial Hygienist
NIOSH - REGION IX
San Francisco, California

Molly J. Coye, M.D., M.P.H.
Medical Investigator
NIOSH - REGION IX
San Francisco, California

Environmental Assistance

Melvin T. Okawa
Regional Program Consultant
NIOSH - REGION IX
San Francisco, California

Report Typed By:

Michael A. Gee
NIOSH - REGION IX
San Francisco, California

X. DISTRIBUTION AND AVAILABILITY OF REPORT

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Copies of this report have been sent to:

1. Civil Service Association, Local 400
2. Department of Municipal Railway - Woods Division
3. CAL-OSHA
4. U.S. Department of Labor - Region IX

For the purpose of informing the affected employees, copies of the report shall be posted by the employer, in a prominent place accessible to the employees, for a period of 30 calendar days.

TABLE I

GAS DETECTOR TUBE RESULTS COLLECTED
AT STOREKEEPING (FIRST AND SECOND FLOORS)
SAN FRANCISCO MUNICIPAL RAILWAY (WOODS DIVISION)
SAN FRANCISCO, CALIFORNIA
September 23, 1980

Contaminant	Location	Time Sampled	Concentration (ppm)[1]
Carbon Monoxide	Storekeeping	0805	5
" "	"	0945	5
" "	Room 219-Top of Stairway	1005	ND[2]
" "	Light Maintenance-next to bus while its running	1045	ND
" "	Storekeeping	1305	5
" "	Room 219-Tope of stairway	1330	7
" "	Storekeeping	1425	ND
Sulfur Dioxide	Storekeeping	0810	ND
" "	Storekeeping	0955	ND
" "	Room 219-Top of stairway	1010	ND
" "	Storekeeping	1315	ND
" "	Room 219-Top of Stairway	1330	ND
" "	Storekeeping	1500	ND
Formaldehyde	Storekeeping	0820	ND
"	Storekeeping	1000	ND
"	Light Maintenance-next to bus while its running	1055	ND
"	Storekeeping	1325	ND
"	Room 219-Top of Stairway	1340	ND
"	Storekeeping	1500	ND
Nitrogen Dioxide	Storekeeping	0830	ND
" "	Storekeeping	1000	ND
" "	Storekeeping	1325	ND
" "	Room 219-Top of Stairway	1335	ND
" "	Storekeeping	1500	ND

1. ppm - Parts of a vapor or gas per million parts of contaminated air by volume.
2. ND - None detected

Range of Measurements

1. Carbon Monoxide - 5-150 ppm or 100-700 ppm
2. Sulfur Dioxide - 1-25 ppm
3. Formaldehyde - 0.5-10 ppm
4. Nitrogen Dioxide - 0.5-1o ppm or 5-25 ppm

TABLE II

SUMMARY OF GENERAL AREA AIR
SAMPLES COLLECTED FOR TOTAL PARTICULATE
SAN FRANCISCO MUNICIPAL RAILWAY (WOODS DIVISION)
SAN FRANCISCO, CALIFORNIA
September 23, 1980

Location	Sample Volume (Liters)	Sample Period	Concentration (mg/m^3)[1]
Storekeeping, Light Maint. Side	689	0730-1510	0.08
Room 219 - Top of Stairway	675	0745-1515	0.07
Storekeeping-Work Order Desk	668	0745-1510	0.13

1. mg/m^3 - milligrams of a substance per cubic meter of air by volume.

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