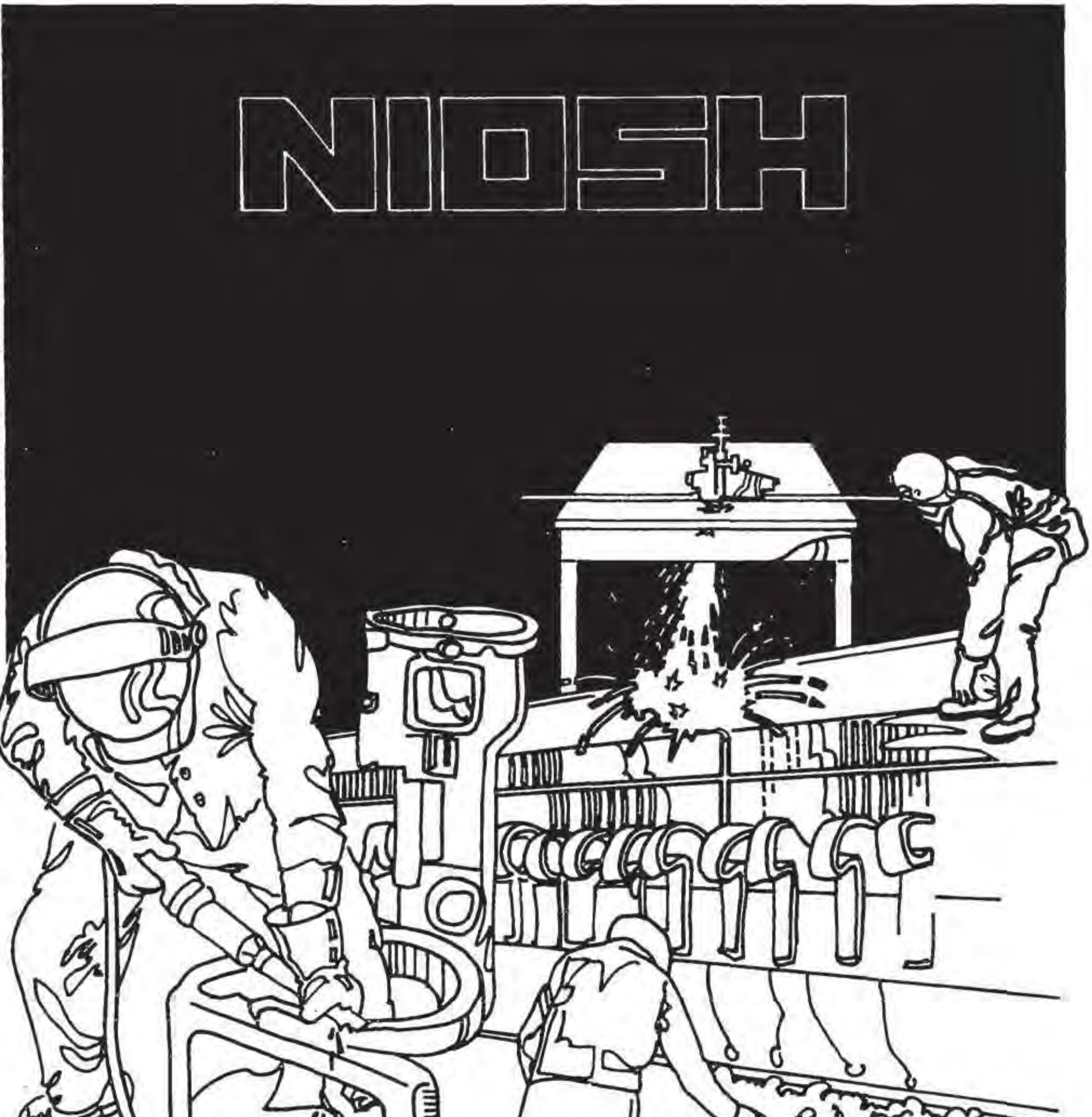
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Publi[illegible] Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health



Health Hazard Evaluation Report

HETA 81-452-1128
SANTA CRUZ METROPOLITAN
TRANSIT DISTRICT
SANTA CRUZ, 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.

HETA 81-452-1128
JUNE 1982
SANTA CRUZ METROPOLITAN
TRANSIT DISTRICT
SANTA CRUZ, CALIFORNIA

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

I. SUMMARY

On August 20, 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request to conduct a health hazard evaluation at the Santa Cruz Metropolitan Transit District (SCMTD). The request concerned bus drivers exposures to raw fuel and bus exhaust fumes leading to cerebral symptoms and irritation.

On September 23-25, 1981, NIOSH investigators conducted an environmental and medical survey of the bus drivers. The bus drivers were evaluated for raw fuel and exhaust fume exposures. Drivers of the gasoline engine buses were monitored for exposure to carbon monoxide (CO), benzene, and alkanes C5-C8 as total hydrocarbons. A bulk gas sample was submitted for analysis of benzene and identification of total hydrocarbons. Direct-reading instruments were simultaneously used to measure peak CO and total hydrocarbons. Peak CO concentrations averaged 6 ppm and peak total hydrocarbon concentrations averaged 3 ppm. No overexposures to CO or alkanes were measured based on NIOSH recommended time-weighted average criteria (CO-35 ppm, alkanes C5 to C8 350 mg/m^3). No benzene was detected in the bulk gas sample. Furthermore, benzene and total hydrocarbon air samples were below the limit of detection (0.01 and 0.07 milligram per tube respectively).

Drivers of the diesel engine buses were monitored for exposure to carbon dioxide (CO_2), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), formaldehyde, and total particulate (soot). A bulk sample of soot was submitted for analysis of polynuclear aromatic (PNA) hydrocarbons. Air samples were collected for CO_2, SO_2, and NO_2 using the appropriate colorimetric detector tubes. The CO_2, NO_2, and SO_2 air concentrations were below the limit of detection. Fourteen air samples were collected for formaldehyde gas; however, none was detected. Five air samples collected for total particulate (soot) ranged from none detectable to 0.06 mg/m^3. This is well below the CAL-OSHA standard of 10 mg/m^3. No PNA's were identified in the bulk soot sample.

Medical questionnaires, and pre- and post-shift carboxyhemoglobin levels were obtained for 17 bus drivers. There were no significant rises in carboxyhemoglobin levels found. However, the diesel bus drivers (8) reported a high prevalence of eye and upper respiratory symptoms, while the gasoline bus drivers reported a high prevalence of headaches and upper respiratory irritation.

Based on the environmental air samples collected on the dates of this study, drivers of gasoline engine buses were not overexposed to CO, benzene, alkanes C5-C8 as total hydrocarbons. Raw fuel odors were periodically smelled on one Bus No. 854, but no overexposure to total hydrocarbons were measured using a direct-reading instrument.

Drivers of diesel engine buses were not overexposed to CO_2, SO_2, NO_2, formaldehyde, total particulate, or polynuclear aromatic hydrocarbons even though diesel fumes were periodically smelled when idling at a light or passenger pick-up point.

Based on the medical evaluations, symptoms among the diesel bus drivers were consistent with intermittent diesel fume exposures, and symptoms among the Wayne Van drivers were more consistent with intermittent uncombusted gasoline vapor exposure. Recommendations to help ensure a safe and healthy workplace are included in Section VII of this report.

KEYWORDS: SIC 4111 (Local and Surburban Transit), diesel and gasoline exhaust fumes, raw gas odor, carbon monoxide, carbon dioxide, nitrogen dioxide, sulfur dioxide, soot, formaldehyde.

II. INTRODUCTION

On August 20, 1981, a request for a health hazard evaluation was submitted to NIOSH by the General Manager for Santa Cruz Metropolitan Transit District (SCMTD). The manager was concerned about 20 to 30 drivers complaints of raw fuel and exhaust fume odors leading to "cerebral symptoms and irritation". Complaints were associated with driving gasoline buses (Wayne Vans) and several of the diesel buses.

On September 23-25, 1981, NIOSH conducted an environmental and medical survey. Environmental air samples were collected and analyzed for several components of gasoline and diesel exhaust which included: carbon monoxide (CO), carbon dioxide (CO_2), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), formaldehyde, total particulate (soot), benzene, and polynuclear aromatic (PNA) hydrocarbons. Environmental air sampling levels measured with direct-reading instruments were discussed by the NIOSH investigators with company and union representatives on the last day of the study.

III. BACKGROUND

The Santa Cruz Metropolitan Transit District requested NIOSH to investigate 20 to 30 bus drivers health complaints while working their shift which varies from 4 to 10 hours per day. Drivers symptoms vary depending on whether they are driving the Wayne Vans (gas buses) or the Grumman Flexibles (diesel bus). Also, the drivers symptoms were reported to be more persistent during hot climatic conditions. Many of the Wayne Vans were thought to have exhaust fume odor problems.

IV. HAZARD EVALUATION DESIGN

A. Evaluation Criteria and Health Complaints

Occupational exposure criteria have been developed to evaluate workers' exposures 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 workweek throughout a working lifetime without experiencing adverse health effects.

TABLE A

Substance	Time-Weighted Average (TWA)[a]	Ceiling Value
Carbon Monoxide (NIOSH)	35 ppm[b]	200 ppm
Carbon Monoxide (CAL-OSHA)	50 ppm	400 ppm
Carbon Dioxide (NIOSH)	10,000 ppm	30,000 ppm (10 min)
Carbon Dioxide (CAL-OSHA)	5,000 ppm	-
Nitrogen Dioxide (NIOSH)	-	1 ppm (15 min)
Nitrogen Dioxide (CAL-OSHA)	5 ppm	5 ppm
Sulfur Dioxide (NIOSH)	0.5 ppm	-
Sulfur Dioxide (CAL-OSHA)	5.0 ppm	-
Formaldehyde (NIOSH)	Lowest feasible limit	-
Formaldehyde (CAL-OSHA)	2 ppm	2 ppm
Total Particulate (NIOSH)	-	-
Total Particulate (CAL-OSHA)	10 mg/m^3[c]	-
Benzene (NIOSH)	-	1 ppm (60 min)
Benzene (CAL-OSHA)	10 ppm	50 ppm
PNA's (NIOSH)	0.1 mg/m^3	-
PNA's (CAL-OSHA)	0.2 mg/m^3	-
Alkanes C5-C8 (NIOSH)	350 mg/m^3	1800 mg/m^3 (15 min)
Alkanes C5-C8 (CAL-OSHA)	-	-

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

Environmental air samples were collected in the gasoline buses for carbon monoxide, total hydrocarbons, and benzene.

A direct-reading carbon monoxide analyzer (Ecolyzer®) was used to measure CO levels in the Wayne Vans. Also a direct-reading survey instrument (HNU-photoionization meter, MODEL PI-101, Serial No. 7342, Span Setting 9.8) was calibrated with benzene and used to measure benzene and other hydrocarbons in the drivers' breathing zone.

Ten personal air samples were collected for benzene and total hydrocarbons using charcoal tubes which were connected to a vacuum pump operating at 100 cubic centimeters per minute.

Five of the samples were analyzed for benzene and five were analyzed for total hydrocarbons according to Physical and Chemical Analytical Method (P&CAM) 127 with minor deviations. The hydrocarbons were analyzed by summing up the number of peak areas and comparing those with the summed areas of those of standards prepared from the liquid gasoline bulk sample supplied.

The results were corrected for desorption efficiencies. The minimum three detectable quantities were 0.01 mg per tube for benzene and 0.07 mg/tube for gasoline (hydrocarbons).

Environmental air samples were collected in the diesel buses for carbon dioxide, sulfur dioxide, nitrogen dioxide, total particulate, and formaldehyde. Air sampling for CO_2, SO_2, and NO_2 was performed using Drager gas detector tubes.

Fourteen personal air samples were collected for formaldehyde using a specially impregnated charcoal tube (chromosorb 102) which was connected to a vacuum pump operating at 50 cubic centimeters per minute. The chromosorb tubes were subsequently analyzed in the laboratory according to NIOSH P&CAM No. 318 with minor variations. Five personal air samples were collected for total particulate (soot) 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 filters were subsequently analyzed in the laboratory by gravimetric method.

A bulk sample of the soot was collected from the lighting fixtures on the inside rear of the bus and at the return airflow grills. The bulk was weighed, extracted with cyclohexane, and filtered. An aliquot was redissolved in acetonitrile and injected into the high-pressure liquid chromatograph and compared to standards containing 16 polynuclear aromatic hydrocarbons (PNA's). The limit of detection was 0.1 ppm for each PNA.

2. Medical Evaluation

On Thursday, September 24, 1981, informal medical interviews were conducted and a questionnaire completed by 17 drivers in the administrative offices. Questions were asked regarding history or recent symptoms of headache, eye, nose, throat, and/or lung irritation. Workers were also asked about what concerns they had related to diesel and gasoline fumes and smoke. A brief questionnarie was administered both for irritative and central nervous system symptoms and as part of the carboxyhemoglobin testing.

Breath samples were taken by having the workers blow an inhalation held for 20 seconds into a sample bag, which was then evacuated into a carboximeter (Ecolyzer). The CO concentration of the samples was determined on the carboximeter. The amount of CO in the sample was converted to percent COHb in the workers' blood, and this value is the value used for biological results reported here. Both pre- and post-shift levels were taken, and smokers were asked not to smoke for the last 4 hours before coming to work and before coming off shift. Workers also were asked not to drink any alcoholic beverages for 4 hours before the shift because alcohol interferes with the Ecolyzer analysis.

C. Toxicological Effects

1. Gasoline Exhaust

There are many components in gasoline exhaust. Carbon monoxide (CO) is the main component of concern as a potential health hazard when it is in high concentrations.

2. Carbon Monoxide (CO)

The signs and symptoms of carbon monoxide poisoning may include headache, nausea, vomiting, dizziness, drowsiness, and collapse. In the bloodstream, carbon monoxide rapidly binds to the oxygen-carrying capacity of the blood. The more COHb is formed, the more significant the symptoms. Heart disease may be made worse in workers who have coronary heart disease and are exposed to carbon monoxide concentrations high enough to produce a COHb level greater than 5%. There is also important evidence that exposure to lower carbon monoxide concentrations, producing COHb levels below 5%, affects the nervous system and causes changes in visual alertness, response time, and fine judgment.(2)

Non-smoking, non-exposed persons have an average COHb level of 1%. Cigarette smokers usually have an average COHb level of 2 to 10%. Non-smokers exposed to 50 ppm of CO for 6 to 8 hours have COHb levels of 8 to 10%. Symptoms such as headache and nausea may be seen above 15%, but usually not at lower levels. At 25%, there may be electrocardiographic evidence of heart effects, and 40% usually results in collapse.

The current CAL-OSHA standard for carbon monoxide is 50 ppm. Exposure at this level for 90 minutes may cause chest pain for persons with angina (chest pain related to heart disease); exposure for 2 hours may make leg cramps worse for persons who have leg cramping associated with vascular disease. The effects of carbon monoxide exposure, including the more common symptoms of headache, dizziness, and nausea, are made worse by heavy labor and a high temperature in the work area.(1)

In 1972, after considering all of these factors, NIOSH recommended an exposure limit of 35 ppm for an 8-hour time-weighted average, and a ceiling limit of 200 ppm. This recommendation is based on the concentration necessary to produce a COHb level of not more than 5%. The recommendation does not consider the smoking habits of workers since the COHb levels in smokers has generally been in the 4 to 5% range, but may run as high as 10 to 15% in heavy smokers. Therefore, smokers who already have a blood level of 5%, and are then exposed in a work place with an average concentration of 35 ppm will have a total COHb of about 10%.(2,5)

CAL-OSHA standard: 50 ppm. NIOSH recommendation: 35 ppm.

3. <u>Diesel Exhaust</u>

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 breathe them while working.

4. <u>Short-Term Effects</u>

a. <u>Formaldehyde and Other Aldehydes</u>

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 ppm). At levels between 1 to 5 ppm, formaldehyde makes the eyes water and sting. At 20 ppm, many people notice stinging 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.(3,4)

Formaldehyde has caused nasal cancer in animal testing as reported by the Chemical Industry Institute of Toxicology. Formaldehyde has also been shown to be a mutagen (cause chromosome changes) in several test systems.

Based on these finds, NIOSH recommends that formaldehyde be handled in the work place as a potential occupational carcinogen and that work practices be employed to control occupational exposures to the lowest feasible limit.

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

CAL-OSHA standard: 2 ppm.
NIOSH recommendation: lowest feasible limit.

b. Nitrogen 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 phlegm (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.(4,8)

CAL-OSHA standard: 5 ppm.
NIOSH recommendation: 1 ppm (15 min).

c. Carbon Monoxide (CO)

Refer to gasoline exhaust.

d. Soot (Total Particulate)

Diesel engines produce 30 to 50 times as much smoke particulate as gasoline engines. This smoke is easily breathed in and becomes trapped in the lungs. It can cause cough and phlegm.(4)

CAL-OSHA standard: 10 mg/m^{5C}

e. Sulfur Dioxide (SO_2)

SO_2 causes symptoms of irritation similar to those caused by NO_2 and formaldehydes.(1)

CAL-OSHA standard: 5 ppm.
NIOSH recommendation: 0.5 ppm.

5. Long-Term Effects

a. Polycyclic Aromatic Hydrocarbons (PAH's)

These are organic chemicals found in very small quantities in diesel fumes. Several of these chemicals are known to cause cancer in laboratory animals and are suspect human carcinogens.

b. 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).(5)

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.

c. 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.(6,7)

V. RESULTS AND DISCUSSION

A. Environmental

All the Wayne Vans were monitored for carbon monoxide, benzene, and alkanes (C5-C8) as total hydrocarbons. Drivers complained about all the vans; however, Bus 855 and 857 received the most drivers complaints. Direct-reading instruments were simultaneously used to measure peak exposure to CO and total hydrocarbons (Table I). Environmental air samples were collected from the drivers breathing zone during one cold engine start, while idling, while traveling at cruising speeds (35 to 40 mph), and whenever raw gas odors were smelled. The CO concentration ranged from 2 to 20 ppm with an average peak concentration of 6 ppm. No overexposures were measured based on the NIOSH recommended criteria, cited in Table A.

The peak hydrocarbon concentrations ranged from 1 to 22 ppm with an average peak concentration of 3 ppm. No overexposure to hydrocarbons (alkanes C5-C8) were measured.

Personal air samples were collected for benzene and total hydrocarbons (C5-C8) using charcoal tubes. No benzene or alkane time-weighted exposures were measured during the survey. A bulk sample of gasoline was supplied to the laboratory to determine whether benzene was present and to determine the hydrocarbon peaks which might be detected in the charcoal tube.

Five Grumman flexible buses (Nos. 858, 863, 864, 867, and 872) were monitored for carbon dioxide, sulfur dioxide, and nitrogen dioxide with colorimetric tubes. Air samples were collected by the investigator while sitting at the back of the bus where fumes were said to be the worst and at the drivers breathing zone. No NO_2 and SO_2 was detected, and CO_2 concentrations were below the limit of detection (<0.1 percent).

Five personal air samples were collected for total particulate (soot). Total particulate concentrations (Table II) ranged from none detectable to 0.06 mg/m^3. This is well below the CAL-OSHA standard of 10 mg/m^3. A bulk sample of soot was submitted for analysis of PNA's; however, none were identified.

Fourteen personal air samples were collected at the breathing zone of the bus driver and the investigator who sat at the back of the bus. No formaldehyde vapors were detected.

It was learned that the Grumman flexible buses have two separate air-conditioning systems which have 20% fresh air and 80% make-up air. The 20% fresh air duct was permanently blocked off by the service department mechanic because the engine exhaust duct, which is located next to the make-up air duct, frequently contaminated the make-up air which resulted in patron complaints. Unfortunately, blocking off the make-up air line has not prevented the diesel fumes from entering the bus while idling. Furthermore, the Grumman flexibles all have stationary windows. Thus, there is no fresh air circulation on days when the fumes are more noticeable (usually hot stagnant days).

Gasoline odors were periodically smelled on one bus (No. 854) at various intervals during the ride (Table I). Even though the gas odors were annoying to the bus driver and the investigator and may have indicated a possible gas line leak, no excessive exposures to total hydrocarbons (which ranged in concentration from 2 to 9 ppm) were measured with the HNU meter nor on the charcoal tube (below the limit of detection).

B. Medical

Table III presents the results of the questionnaires completed by the drivers. All of the eight diesel bus drivers had symptoms including eye, nose and throat irritation, headache, dizziness, and fatigue. The Grumman drivers reported few symptoms. Three of the Wayne Van drivers reported symptoms; their complaints emphasized headaches and dizziness more than eye and throat irritation, a reversal of the pattern among the GMC diesel bus drivers.

The carboxyhemoglobin (COHb) testing results for the drivers are presented in Table IV. GMC and Grumman (diesel) drivers had no significant COHb rise. They had widespread complaints, primarily of eye, nose and throat irritation, headache, and dizziness (Table III). This is consistent with a diesel exhaust effect.

Wayne and twincoach drivers had no significant COHb rise. Only some had complaints, but those with complaints mentioned headache, dizziness, fatigue, and being bothered by fumes more than eye or nose and throat irritation. This is consistent with a raw gasoline vapor effect more than an exhaust problem.

VI. CONCLUSION

None of the Wayne drivers were exposed to benzene or received overexposure to carbon monoxide or alkanes, C5-C8 as (total hydrocarbons). None of the diesel bus drivers were overexposed to CO_2, NO_2, SO_2, total particulate (soot or PNA's), or formaldehyde. However, drivers reported intermittent acute symptoms of exposure to gasoline odors and exhaust fumes (headaches and dizziness) and diesel exhaust fumes (eye, nose, and throat irritation) which is consistent with the medical literature. These symptoms are not explained by smoking habits, and they are reported to be aggrevated by hot stagnant air.

VII. RECOMMENDATIONS

1. An educational program should be developed to inform workers about the potential hazards of gasoline and diesel exhaust fumes and raw gas odors.

2. Buses which have persistent raw gas odors should be reported to their supervisors to determine the cause of the problem.

3. Buses which appear to be running rough should be reported to their supervisor.

4. Consideration should be given to installing movable windows in the Grumman flexibles to allow more fresh air to circulate in the buses.

VIII. REFERENCES

1. Procter, Nick H., Hughes, James P., Chemical Hazards of the Workplace, J.B. Lippincott, Philadelphia, 1978.

2. Criteria for a Recommended Standard: Occupational Exposure to Carbon Monoxide, DHEW (NIOSH) Pub. No. 73-11000.

3. Criteria for a Recommended Standard: Occupational Exposure to Formaldehyde, DHEW (NIOSH) Publication No. 77-126.

4. Formaldehyde: Evidence of Carcinogenicity, NIOSH Current Intelligence Bulletin No. 34, April 15, 1981. DHHS (NIOSH) Pub. No. 81-111.

5. Health Hazard Determination: White Pass and Yukon Railroad, DHEW (NIOSH) Publication No. 74-1-160.

6. Criteria for a Recommended Standard: Occupational Exposure to Carbon Black, DHEW (NIOSH) Pub. No. 78-204.

7. Criteria for a Recommended Standard: Occupational Exposure to Sulfur Dioxide, DHEW (NIOSH) Pub. No. 74-111.

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

9. Criteria for a Recommended Standard: Occupational Exposure to oxides of Nitrogen (nitrogen dioxide and nitric oxide), DHEW (NIOSH) Pub. No. 76-149.

10. Criteria for a Recommended Standard: Occupational Exposure to Alkanes (C5-C8), DHEW (NIOSH) Pub. No. 77-151.

11. NIOSH Manual of Sampling Data Sheets, DHEW (NIOSH) Pub. No. 77-159.

12. NIOSH Manual of Sampling Data Sheets, Supplement, DHEW (NIOSH) Pub. No. 78-189.

13. NIOSH Manual of Analytical Methods, DHEW (NIOSH) Pub. No. 82-100.

IX. AUTHORSHIP

Report Prepared by:

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

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

ACKNOWLEDGEMENTS

	Melvin T. Okawa Regional Program Consultant NIOSH - REGION IX San Francisco, California
Analytical Laboratory Service:	Measurement Service Section Measurement Support Branch NIOSH Cincinnati, Ohio
Report Typed By:	Nancy A. Luciano Secretary NIOSH/DPHS San Francisco, California

X. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 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. Santa Cruz Metropolitan Transit District
2. United Transportation Union, Local No. 23
3. CAL-OSHA
4. U.S. Department of Labor - REGION IX

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

TABLE I

Peak Environmental Air Samples Collected for CO and Total Hydrocarbons in the Wayne Vans

Santa Cruz Metropolitan Transit District
Santa Cruz, California
HETA 81-452

September 24, 1981

CONTAMINANT (ppm)[1]

Vehicle Number	Time	CO[2]	Total Hydrocarbons[3]	Comment
856	0545	20	-	Cold engine start
	0550	12	-	After five minutes
	0600	8	1	1st stop
	0615	3	1	Traveling 45 mph
	0645	2	1	Traveling 45 mph
	0700	2	1	Traveling 45 mph
	0720	4	1	Transit Center (idling)
	0730	4	1	Transit Center (idling)
	0745	3	-	County Hospital (idling)
	0800	8	-	Transit Center (idling)
	0815	10-11	-	Traveling 45 mph (bus full)
	0845	1-2	-	Traveling 45 mph (bus empty)
	0900	2-3	-	Traveling 25-30 mph
	0915	2-3	-	Traveling 25-30 mph
	0930	8-9	-	End of Run (Transit Center)

(CONTINUED)

TABLE I (CONTINUED)

Vehicle Number	Time	CO[2]	Total Hydrocarbons[3]	Comment
		CONTAMINANT (ppm)[1]		
854	1100	4-7	4	Smell raw gas odors for about 10 minutes traveling 25-30 mph
	1110	5-7	5-6	Smell raw gas odors for about 10 minutes traveling 25-30 mph
	1120	3-4	2-3	Smell raw gas odors for about 10 minutes traveling 25-30 mph
	1130	3-4	2-3	Smell raw gas odors for about 10 minutes traveling 25-30 mph
	1300	5	3	Idling
	1310	12	3	Idling
	1311	5	9	Smell raw gas odors
	1315	4	7	Smell raw gas odors
	1325	2	3	End of line
	1335	12	2	Suspect alcohol interference with instrument
	1340	25	7	Suspect alcohol interference with instrument
	1350	2	2	End of line
852	0740	6	2	Idling
	0750	4	6-7	Idling at Transit Center
	0800	5	8-9	Traveling 35 mph
	0815	5	10-22	Up hill route
	0820	20	7	Near Highway No. 17
	0830	0	6-8	Traveling 35 mph
	0845	5	15	Traveling 35 mph
853	0853	3	3	Idling at Transit Center
	0900	1	2	Traveling up hill
	0905	3	2	Traveling 35 mph
	0915	5-6	2	Traveling 35 mph
	0925	6	2	Traveling 35 mph
	0930	1	2	Traveling 35 mph
	0935	6	2	Traveling 35 mph
857	1445	5	1-4	Idling at Transit Center
	1450	15	5	Traveling 35 mph
	1500	3	1.5	Traveling 35 mph
	1515	2	1	Traveling 35 mph
	1530	1	1	Traveling 35 mph
	1545	7	2	Traveling 35 mph

1) ppm - parts of a vapor or gas per million parts of air.
2) Measurements using an Ecolyzer instrument.
) Measurements using an HNU Photoionization Detect

TABLE II

Personal Air Samples Collected From Drivers of Grumman Buses for Total Particulate (Soot)

Santa Cruz Metropolitan Transit District
Santa Cruz, California
HETA 81-452

September 25, 1981

Bus Number	Sample Volume (liters)	Sample Period	Concentration (mg/m^3)[1]
858	680	0640 - 1345	0.06
872	720	0635 - 1405	0.05
864	678	0645 - 1355	N.D.[2]
863	675	0655 - 1400	0.04
867	322	0624 - 0943	0.03

1) mg/m^3 - milligrams of a substance per cubic meter of air
2) N.D. - none detected

TABLE III

Symptoms Reported to be Associated with Drivers Exposure

Santa Cruz Metropolitan Transit District
Santa Cruz, California
HETA 81-452

September 24-25, 1981

Drivers		
GMC:	<u>All</u> of the eight drivers had symptoms:	
	eye irritation	5
	nose and throat irritation	3
	headache	3
	dizzy	2
	tired after work	2
GRUMMAN:	Two of the three drivers had symptoms:	
	eye irritation	1
	nausea and decreased appetite	1
	tired after work	1
	headache	1
WAYNE:	Three of the six drivers had symptoms:	
	headache	3
	dizzy	2
	tired after work	2
	fume/bothered	1
	nose and throat irritation	2
	nausea	1

TABLE IV

Carboxyhemoglobin Levels (%) for Drivers

Santa Cruz Metropolitan Transit District
Santa Cruz, California
HETA 81-452

September 24-25, 1981

	Pre-Shift	Post-Shift	Change
GMC	1.9	1.9	0
	1.5	1.6	+ .1
	1.8	1.7	- .1
	1.7	2.0	+ .3
	1.7	1.8	+ .1
	1.3	1.5	+ .2
	1.6	1.5	- .1
	1.5	1.7	+ .2
			$\bar{x}$ = .1 rise
GRUMMAN	1.5	1.9	+ .4
	1.5	1.7	+ .2
	1.3	1.5	+ .2
			$\bar{x}$ = .3 rise
WAYNE	5.0*	5.0*	0
	3.1	2.4	- .7
(one twincoach	8.9	8.7	- .2
driver included)	1.7	2.1	+ .4
	1.3	2.0	+ .7
	1.3	1.7	+ .5
	1.9	2.1	+ .2
	1.9	1.7	- .2
			$\bar{x}$ = .1 rise

* This driver had smoked a cigarette 1/2 hour before 1st testing and 1-1/2 hours before 2nd testing.

DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTERS FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
ROBERT A. TAFT LABORATORIES
4676 COLUMBIA PARKWAY, CINCINNATI, OHIO 45226

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

Third Class Mail

U.S. MAIL

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF HHS
HHS 396