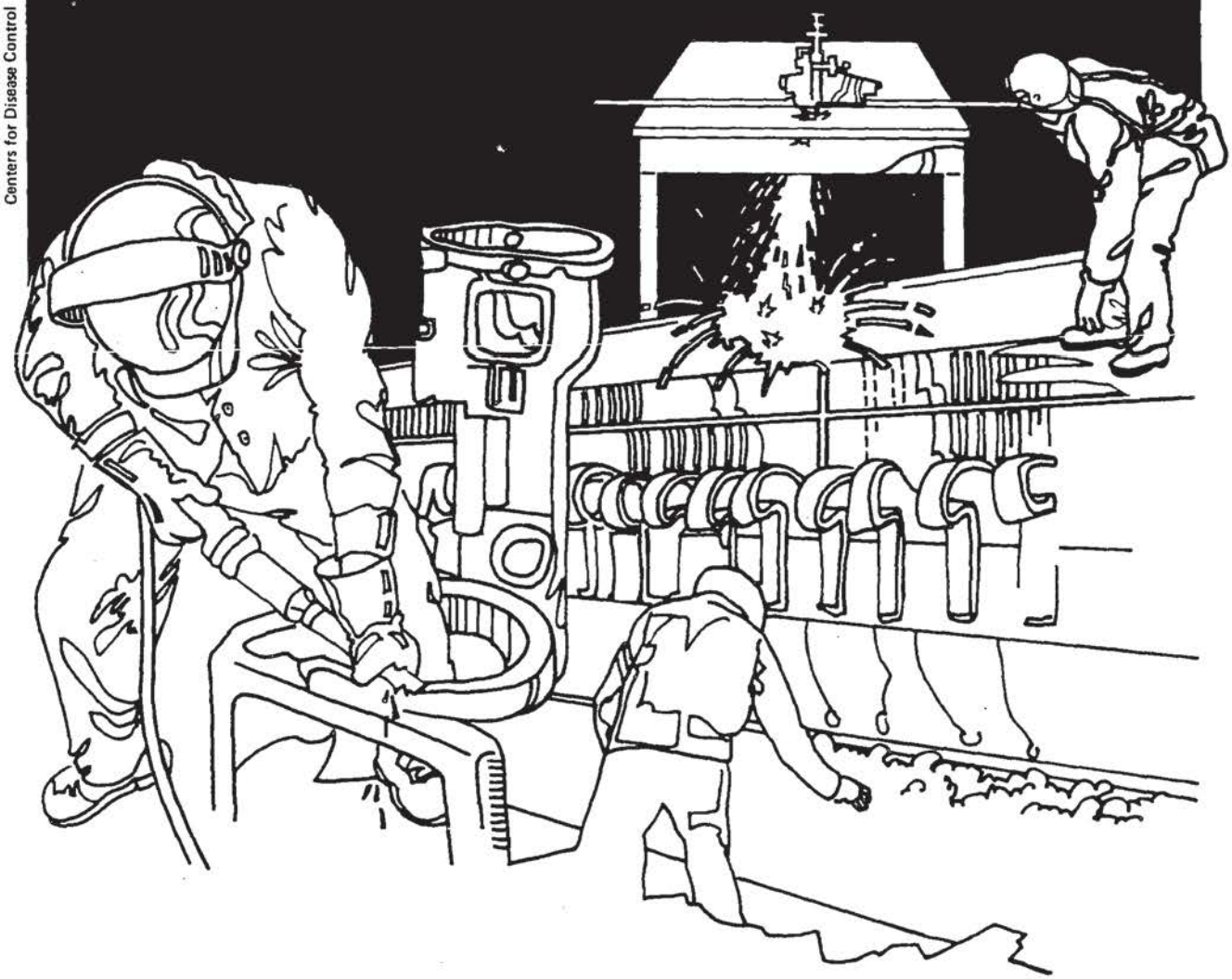
NIOSH



Health Hazard Evaluation Report

HETA 85-436-1886
ROARING FORK TRANSIT AGENCY
ASPEN, COLORADO

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 85-436-1886
APRIL 1988
ROARING FORK TRANSIT AGENCY
ASPEN, COLORADO

NIOSH INVESTIGATORS:
Paul Pryor, M.S., CIH
Bobby J. Gunter, Ph.D., CIH

I. SUMMARY

In July 1985, the National Institute for Occupational Safety and Health (NIOSH) received a request from a representative of Roaring Fork Transit Agency, Aspen, Colorado to evaluate bus diesel emissions in the bus storage barn. On August 21-22, and December 3-4, 1985, NIOSH investigators conducted industrial hygiene surveys to determine airborne concentrations of bus diesel exhaust. Compounds which were selected for evaluation were sulfur dioxide, nitrogen dioxide, total particulates, formaldehyde and carbon monoxide. Work practices and techniques were observed and employees were informally interviewed.

Sample results indicated sulfur dioxide levels ranging from non-detected (ND) to 0.27 mg/m^3. The NIOSH recommended exposure limit (REL) for sulfur dioxide is 1.3 mg/m^3. Nitrogen dioxide levels ranged from ND to 0.02 mg/m^3. The REL for nitrogen dioxide is 1.8 mg/m^3. Area sample results for total particulates and formaldehyde respectively ranged from 0.02 to 0.9 mg/m^3, and 0.004 to 0.10 mg/m^3. The American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) for total nuisance particulates is 10 mg/m^3. NIOSH currently recommends that formaldehyde be controlled to the lowest feasible limit. Individual carbon monoxide readings ranged from 4 to 40 parts per million (ppm) with the higher levels being found while non-diesel traffic was in the maintenance area. The 8-hour time-weighted average (TWA) levels for carbon monoxide, however, were below both the OSHA standard of 50 ppm and the NIOSH REL of 35 ppm. Slightly higher contaminant levels were found during the winter survey versus the summer survey, but all levels were well below recommended limits. Carbon monoxide levels at the air intake for the reservationist's room were found to range from 7 to 350 ppm resulting in short term carbon monoxide levels in the reservationist's room of 7 to 35 ppm. Levels dropped quickly when automobile activity in the parking area dropped.

Interviews with employees indicated reported symptoms of eye, nose and throat irritation and headaches. A review of the ventilation system indicated a number of deficiencies and a need for a better working knowledge of the system.

On the basis of the data collected, NIOSH investigators concluded that a health hazard did not exist to the employees who work in the bus storage barn during this evaluation. It was determined, however, that the exposure levels were higher in the winter time and a portion of the storage/maintenance barn exhaust ventilation was either malfunctioning or not operating adequately to exhaust all the diesel emissions in the maintenance area. While none of the individual environmental exposures exceeded NIOSH guidelines, the reported employee symptoms have been previously found in environments with diesel exhaust. Further improvements in ventilation may reduce or eliminate these symptoms. A potential hazardous exposure to carbon monoxide from automobile emissions was identified in the reservationist's area. Recommendations to assist in preventing and/or reducing exposures are included in this report.

KEYWORDS: SIC 4171 (Terminal and Joint Terminal Facilities for Motor Vehicle Passenger Transportation), diesel maintenance operations, diesel and auto emissions, carbon monoxide, sulfur dioxide, nitrogen dioxide, formaldehyde, total particulates.

II. INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) received a request in July 1985 from a representative of the employees at Roaring Fork Transit Agency, Aspen, Colorado. The request was to determine if there was a health hazard to employees who work in the bus repair and storage area from diesel emissions from buses as they were first started in the morning, during idling periods, driven from and into the storage area and during maintenance procedures. Employee complaints included eye, nose and throat irritation and occasional headaches.

Due to management and employee concerns regarding summer versus winter environmental conditions, surveys were performed on August 21-22, and December 3-4, 1985. In the summer all doors to the bus barn storage area are kept open, while in the winter months all doors are opened only if buses are leaving or returning to the bus barn. The results and recommendations from each investigation were presented to management and the employees as they became available. A summary of concerns and recommendations were presented to management in December 1985.

III. BACKGROUND

Roaring Fork Transit Agency, Aspen, Colorado has been operating in and around the Aspen area for many years. In 1984 the transit authority built a new facility to house and maintain the buses and this facility was considered to be state-of-the-art for transit storage and maintenance.

Approximately one year later a number of concerns were raised regarding the ability of the ventilation system to adequately remove the air contaminants generated by the buses. Management and employees were interested in knowing if the contaminants generated from the buses were sufficient to produce a health hazard to the employees.

In general, it was known that the bus schedule is lighter in the summer versus winter by approximately half (approximately 15 versus 40 buses) and that bus start-up and idling time is longer in the winter. The new building specifications were designed to offset these conditions and eliminate the majority of contaminants during peak and off peak periods. The following information describes the primary operations of the original bus flow and the ventilation system:

A. Operations/Bus Movements

1. About 5:00 a.m., a mechanic would arrive to check and ready the buses. He would start a bus about 5 minutes before it was due to be dispatched, and after checking its lights, etc., would move it outside to a staging area, leaving the engine running, for pickup by the driver. It was anticipated that only a few buses would be idling at a time inside the building. Buses would be dispatched on a first-in, first-out basis starting from the east and exiting the west doors. Only the first three buses parked in the circulation lane have to exit through the south doors.

2. A small portion of the fleet, used for commuter runs, returns in mid-morning through the north door and is parked at the west end of storage. These buses are usually dispatched in late afternoon out the west doors.

3. During the day, mechanics will move a few buses to the storage area from repair, and a few others from storage, outside, and then back in to repair through the north door. Any engine running in a repair stall requires that the bus be hooked up to the tail pipe exhaust system.

4. Upon evening return, the driver parks the bus outside the fueling lane and leaves it there. Mechanics drive the bus into the fueling lane where the engine is stopped. Upon completion of fueling and/or brake inspection, the bus is driven through the washer, and parked at the interior cleaning area where the engine is stopped. Upon completion of interior cleaning, the bus is driven to the storage area where the engine is stopped. The lanes are to be filled fully from west to east so there is no need to reshuffle buses later. The last buses to return fill the circulation lanes, thus blocking the repair stalls. (This is not a problem since the mechanic's shift has already gone home and does not start again until these buses have been dispatched or at least moved into the storage area the following morning.)

B. Ventilation System

1. The ventilation system was designed to either conform to or exceed requirements of 1 cubic foot per minute (CFM) of outside air per square foot of floor area. The 1 CFM/f^2 outside air is designed as the level of ventilation needed to maintain exhaust pollutants below OSHA recommended criteria. This is based upon gasoline engines, and is conservative for diesel engines.

2. The overall ventilation scheme is to introduce the outside air in the zones of primary worker exposure, and then let it migrate through the areas of progressively greater tail pipe emissions, tending to keep the more offensive air in the zones that are occupied only intermittently by workers. The ventilation rates are staged in three progressive levels.

   a. In stage 1, the maintenance areas (those east of column line 4) are continuously ventilated during occupied hours by a 20,000 CFM make-up air unit, MUA-1, and exhaust fan, EF-3, both drawing through a heat recovery unit. This system is operated by a time clock. Anticipated hours of operation were 5:00 a.m. until 1:00 a.m. the following morning. Most of the air is introduced into the east end offices, parts, and unit repair. This uncontaminated air then migrates through the repair stalls to the circulation lanes, with exhaust in the cleaning areas.

      Service lane ventilation air is introduced into the brake inspection pit in the service lane to continuously flush this area of diesel vapors and engine exhaust fumes. Part of this air is exhausted near the pit floor. The remainder of the air is exhausted by hoods in the vicinity of engine tail pipes at the fueling lane and at the interior cleaning area. During the hours that the outside air ventilation system is operating at the first stage level, the bus storage exhaust fan, recirculates 10,000 CFM of air from the west end of storage through particulate and odor removal filters, reintroducing this partially cleaned air at the east end of the storage area.

   b. Stage 2 ventilation operated simultaneously with Stage 1 makeup during the hours of considerable bus activity in the storage and circulation areas. A second make-up air unit, adds a second 20,000 CFM of outside air which is introduced in the occupied bus repair area and migrates through the unoccupied storage area where it is exhausted to the outdoors from the west end by running at high speed (20,000 CFM). The anticipated hours of operation were from 5:00 a.m. until about 9:00 a.m., and from about 6:00 p.m. until 1:00 a.m. This second stage is started either manually by the supervisor, or by automatic oxygen sensors that measure the reduction of oxygen in the space.

   c. Stage 3 ventilation operates when the paint booth is turned on. When its 25,000 CFM exhaust fan, EF-4, is started, MUA-2 runs at high speed, delivering 30,000 CFM, and EF-1 operates at low speed, exhausting 10,000 CFM. Painting normally occurs during the middle of the day, and is not simultaneous with peak bus dispatch or return operations.

3. Secondary local exhaust systems are as follows:

   a. An underfloor engine exhaust system with 5 inch diameter retractable tail pipe adaptor hoses is furnished. Outlets are located at each end of each repair stall. The vehicles with high tail pipe outlets require the use of 5 inch diameter "cane" adaptor. Exhaust volume is 400 CFM per outlet based upon 3 outlets in simultaneous use. The fan, EF-8 is started locally by mechanics.

   b. The battery room is exhausted to the outdoors continuously. The charger is interlocked to shut-down if the fan, EF-7, stops running.

   c. Fumes are drawn through the hot agitating washer by an exhaust fan that runs continuously.

IV. DESIGN AND METHODS

Diesel emissions contain a complex mixture of toxic contaminants; sampling was conducted for five major components. Compounds selected for evaluation were sulfur dioxide, nitrogen dioxide, total particulates, carbon monoxide and formaldehyde. Environmental samples were taken in each of the areas of concern. Both personal breathing zone and area sampling were performed. A variety of sampling techniques were used to evaluate the targeted contaminants in this study.

A. Sulfur Dioxide

A total of 28 samples were collected for sulfur dioxide during the 2 surveys, 16 personal and 12 area samples. Samples were collected on AA filters impregnated with potassium hydroxide at a flowrate of 1.5 liters per minute (lpm). The samples were analyzed by NIOSH Method P&CAM 268.

B. Nitrogen Dioxide

Twenty eight samples were also collected for nitrogen dioxide during the two surveys. Sixteen personal samples and 12 area samples were taken using passive monitoring tubes (Palmes) and analyzed by NIOSH Method 6700.

C. Total Particulates

A total of 12 area samples were collected for total particulates. Samples were collected on FWSB filters at a flowrate of 1.5 lpm. Total particulate levels were determined by taking the differences in pre/post-tared weights.

D. Formaldehyde

Twelve area samples were collected for determination of formaldehyde concentrations. The samples were collected in impingers containing sodium bisulfite and analyzed according to NIOSH Method P&CAM 125.

E. Carbon Monoxide

A total of 20 locations were evaluated for carbon monoxide (CO) levels during the 2 surveys. A portable direct reading CO analyzer was used for this assessment.

During the survey six employees were interviewed to determine if employees were experiencing symptoms.

V. EVALUATION CRITERIA

A. Environmental

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels for time weighted averages (TWA) exposures to which most workers may be exposed to average airborne concentrations of a substance during a normal 8 to 10 hour day, 40 hour week for a working lifetime without experiencing adverse health effects. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

It is important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medication or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs), and 3) the U.S. Department of Labor (OSHA) occupational health standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended exposure limits by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is required to meet those levels specified by an OSHA standard. However, it should be recognized that evaluation criteria may change over the years as new information on the toxic effects of an agent become available. Both NIOSH criteria and recommendations and the ACGIH TLVs usually are based on more recent information than are the OSHA standards.

A time-weighted average (TWA) exposure level refers to the average airborne concentration of a substance during a normal 8 to 10-hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

No standards or environmental exposure criteria have been recommended for "diesel emissions" per se. The environmental evaluation criteria for the individual contaminants monitored during this investigation are presented in Table 1. Recommended environmental limits and human health effects concerning each substance are listed in the table, along with the source of the recommended limits and the present OSHA standard.

VI. ENVIRONMENTAL RESULTS AND DISCUSSION

Tables 2 and 3 present results of area and personal sampling for formaldehyde, total particulates, sulfur dioxide and nitrogen dioxide.

1. Sulfur Dioxide

The results for sulfur dioxide for the first (summer) survey ranged from non-detected (ND) to 0.08 mg/m^3. Sulfur dioxide during the winter survey period ranged from 0.02 to 0.30 mg/m^3. All results were well below both the NIOSH criteria (1.3 mg/m^3) and the OSHA standard (13 mg/m^3).

2. Nitrogen Dioxide

Nitrogen dioxide levels for both personal and area samples during the summer survey were all non-detectable. Levels during the winter survey ranged from ND to 0.02 mg/m^3. The NIOSH and OSHA recommended levels are respectively 1.8 mg/m^3 and 9 mg/m^3.

3. Total Particulates

Area total particulate levels were slightly higher during the winter survey (range 0.05 - 0.90 mg/m^3) than during the summer survey (range 0.02 - 0.20 mg/m^3). All levels, however, were well below the nuisance dust criteria.

4. Formaldehyde

Area formaldehyde concentrations were also slightly higher during the winter survey (range 0.01 - 0.10 mg/m^3) than during the summer survey (range 0.004 - 0.01 mg/m^3). NIOSH recommends that formaldehyde be controlled to the lowest feasible level.

5. Carbon Monoxide

Ten measurements for CO were made in the terminal area and the package receiving department. The results ranged from 6 to 40 parts per million (ppm) in the terminal area and 5-7 ppm in the package receiving area. All of the samples were taken for approximately 5 minutes and all of the higher levels found (20-40 ppm) returned to background levels (6-10 ppm) within only a few minutes after the buses' departure or arrival. All of these results were below the NIOSH 35 ppm criterion and the OSHA 50 ppm standard.

Additional measurements for carbon monoxide were made in the reservationist's room and at the air make-up source located in the parking garage area. The levels measured at the air make-up source (building air inlet) ranged from 7 to 350 ppm and the higher levels were found during peak traffic flows, i.e., while automobiles were pulling in and out of this parking area. The results obtained in the reservationist's room during approximately the same periods as those measured in the garage ranged from 7 to 35 ppm. All of the results found at the air inlet point and in the reservationist's room dropped to 7 to 10 ppm approximately 10 to 15 minutes after the peak automobile traffic had stopped or left the parking area in question. Based on the environmental results and the complaints reported to NIOSH, there does appear to be a potential exposure from auto emissions, especially carbon monoxide, during certain periods of the day to the reservationists.

6. Employee Interviews

The results of the employee interviews indicated three of six employees experiencing health complaints. Two individuals reported irritation of the nose and throat and some eye irritation. Other complaints by the three included: dermatitis (1), backache (1) and headache (1).

VII. CONCLUSIONS

Results of samples collected during both surveys confirm the presence of sulfur dioxide, nitrogen dioxide, total particulates, formaldehyde and carbon monoxide in the work area. Results were slightly higher during the winter survey versus the summer survey, however, all results were well below recommended criteria for individual contaminants measured. Based on the environmental data collected by NIOSH investigators, there did not appear to be a health hazard to the employees who work in and around the terminal area from diesel emissions. However, it should be recognized that even though the results obtained were relatively low for the contaminants of diesel exhaust evaluated in the terminal area this does not prevent that person or persons who may be hypersensitive, as described in the criteria section of this report from reacting to low level contaminants.

This investigation was also not able to evaluate normal conditions and/or unusual conditions during the study period. That is, once we began this study the local RTD had gone on strike and thus the contribution of emissions in the terminal area from this source was not included for the sampling periods in question. Finally, we were also not able to sample during an inversion period nor while any buses were running in the terminal for extended periods of time due to weather conditions (hot or cold periods) as described by the employees who work in this area.

Based upon environmental results a potential health hazard does exist to reservationists from carbon monoxide which was contaminating the air make-up inlet source located in the parking garage area.

VIII. RECOMMENDATIONS

In view of the findings of NIOSH's environmental study, as well as personal communications with workers, the following recommendations are made to assist in providing a better work environment for the concerned employees:

A. Terminal Area

1. The reduction in buses no longer using this terminal area, i.e., RTDs moving in March 1983, does not preclude the potential for irritation to the employees from emissions being generated from those buses still operating in this terminal area. Therefore, it is recommended that some action be taken to reduce and/or eliminate the build-up of these emissions in the area where the buses park in the terminal. The following are examples of steps which could assist in this process:

   a. If possible all buses should be turned off after entering the terminal area.

   b. If certain climatic conditions (hot or cold weather) require the buses to remain running in order to maintain the interior temperature of the bus then a means to exhaust the emissions from the buses tail pipe should be developed. This could be an exhaust system with flexible ducting which extends down to the buses exhaust pipe. An alternative to the exhausting of the buses emissions would be an exterior means of heating or cooling the interior of the bus during those periods required. A heating/refrigeration type system is presently being used by another bus company which operates on the other side of the Denver terminal. This system effectively meets the needs of the heating and cooling concerns of the buses interior and would then eliminate the need for running the buses during hot or cold periods.

B. Reservationist's Area

1. Periodic evaluation/maintenance should be performed on the air vents in the offices located in the terminal.

2. The make-up air source located in the parking garage should be extended to the roof. Until this can be accomplished the parking stalls immediately around this location should be blocked off and thus prevent automobiles from parking at these areas.

IX. REFERENCES

1. NIOSH Pocket Guide to Chemical Hazards, DHEW (NIOSH) Publication No. 78-210.

2. Industrial Hygiene and Toxicology, second edition, Frank Patty (editor), Interscience Publishers, 1967, Vol. II.

3. Encyclopedia of Occupational Health and Safety, International Labor Office, McGraw-Hill Book Company, New York.

4. U.S. Department of Health, Education, and Welfare. Occupational Diseases, A Guide to Their Recognition, Public Health Service Publication (NIOSH) No. 77-181.

5. Handbook of Noise Measurement, seventh edition, Arnold Peterson and Ervin Gross, 1974.

6. Proctor, N.H. and Hughes, J.P., Chemical Hazards of the Workplace, J.P. Lippincott Company, Philadelphia, 1978, pp. 112-113.

X. AUTHORSHIP AND ACKNOWLEDGMENTS

Report Prepared By:

Paul Pryor, M.S., CIH
Industrial Hygienist
NIOSH, Denver Region
Denver, Colorado

Bobby J. Gunter, Ph.D.
Regional Industrial Hygienist
NIOSH, Denver Region
Denver, Colorado

Originating Office:

Hazard Evaluations and Technical Assistance Branch
Division of Surveillance, Hazard Evaluations and Field Studies
Cincinnati, Ohio

XI. DISTRIBUTION AND AVAILABILITY

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. 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. Roaring Fork Transit Agency
2. U.S. Department of Labor/OSHA - Region VIII
3. NIOSH - Denver Region
4. Colorado Department of Health
5. State Designated Agency

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

TABLE 1

Evaluation Criteria and Toxicology

Roaring Fork Transit Agency
Aspen, Colorado

Substance	Primary Health Effects	Reference Source	Recommended Environmental Limit[A]	OSHA Standard
Carbon Monoxide	Headaches; nausea; weakness; dizziness; confusion; loss of consciousness.	NIOSH	35 ppm (C)200 ppm	50 ppm
Sulfur Dioxide	Irritation to eyes, nose, throat; choking; cough.	NIOSH	1.3 mg/m^3	13 mg/m^3
Nitrogen Dioxide	Cough; mucoid frothy sputum; dyspnea; chest pain; pulmonary edema; eye irritation.	NIOSH	1.8 mg/m^3	9 mg/m^3
Total Particulate	Considered an irritation to the eyes and mucous membrane.	ACGIH[B]	10 mg/m^3	15 mg/m^3
Formaldehyde	Refer to notation listed below.	NIOSH	LFL	3 mg/m^3*

A All air concentrations are expressed as time-weighted averages (TWA) exposures for up to a 10 hour workday unless designated (C) for Ceiling which should not be exceeded.

B ACGIH = American Conference of Governmental Industrial Hygienists.

mg/m^3 = Approximate milligrams of substance per cubic meter of air.

*Note: This level is based on formaldehyde's irritant effects (1976 NIOSH Criteria for Recommended Standard). Subsequently, it has been shown to cause cancer in animals. Exposure should, therefore, be controlled at the Lowest Feasible Level (LFL).

TABLE 2

Area Samples for Formaldehyde,
Total Particulates, Sulfur Dioxide, and Nitrogen Dioxide

Roaring Fork Transit Agency
Aspen, Colorado

Area Description	Sampling Time (minutes)	mg/m^3 FMDH	TPTL	SO_2	NO_2
AUGUST SURVEY					
Bus Lane - East	720	0.008	0.20	ND	ND
Bus Lane - West	720	0.007	0.06	0.04	ND
Fuel - Wash	660	0.007	0.06	0.03	ND
Bus Lane - Center	660	0.004	0.06	0.04	ND
Work Bench	600	0.01	0.02	0.03	ND
Wash Area - End	600	0.01	0.03	0.04	ND
DECEMBER SURVEY					
Bus Lane - East	810	0.10	0.40	0.30	0.009
Bus Lane - West	765	0.01	0.40	0.14	0.008
Fuel - Wash	765	0.04	0.39	0.25	0.009
Bus Lane - Center	675	0.04	0.34	0.27	0.008
Work Bench	675	0.03	0.05	0.09	0.009
Wash Area - End	675	0.05	0.90	ND	0.007
EVALUATION CRITERIA	NIOSH	LFL	----	1.3	1.8
	OSHA	3.7	15	13	9
LIMIT OF DETECTION (per sample)		0.1 ug	0.01 mg	4 ug	3 ug

mg/m^3 = milligrams of substance per cubic meter of air
ug = micrograms
mg = milligrams
ND = Non-Detectable
FMDH = Formaldehyde
TPTL = Total Particulates
SO_2 = Sulfur Dioxide
NO_2 = Nitrogen Dioxide

TABLE 3

Personal Samples for
Sulfur Dioxide and Nitrogen Dioxide

Roaring Fork Transit Agency
Aspen, Colorado

Personal Description	Sampling Time (minutes)	mg/m^3 FMDH	mg/m^3 TPTL	SO_2	NO_2
AUGUST SURVEY					
Individual A	810	Area Only	Area Only	0.01	ND
Individual B	810	Area Only	Area Only	ND	ND
Individual C	810	Area Only	Area Only	ND	ND
Individual D	810	Area Only	Area Only	ND	ND
Individual A	810	Area Only	Area Only	0.01	ND
Individual B	810	Area Only	Area Only	0.01	ND
Individual C	810	Area Only	Area Only	0.005	ND
Individual D	810	Area Only	Area Only	0.02	ND
DECEMBER SURVEY					
Individual A	810	Area Only	Area Only	0.07	0.02
Individual B	810	Area Only	Area Only	0.09	ND
Individual C	810	Area Only	Area Only	0.11	ND
Individual D	810	Area Only	Area Only	0.02	0.02
Individual A	810	Area Only	Area Only	0.13	0.02
Individual B	810	Area Only	Area Only	0.11	0.02
Individual C	810	Area Only	Area Only	0.02	ND
Individual D	810	Area Only	Area Only	0.02	ND
EVALUATION CRITERIA: NIOSH		LFL	----	1.3	1.8
OSHA		3.7	15	13	9
LIMIT OF DETECTION (per sample)		0.1 ug	0.01 mg	4 ug	3 ug

mg/m^3 = milligrams of substance per cubic meter of air
ug = micrograms
mg = milligrams
ND = Non-Detectable
FMDH = Formaldehyde
TPTL = Total Particulates
SO_2 = Sulfur Dioxide
NO_2 = Nitrogen Dioxide