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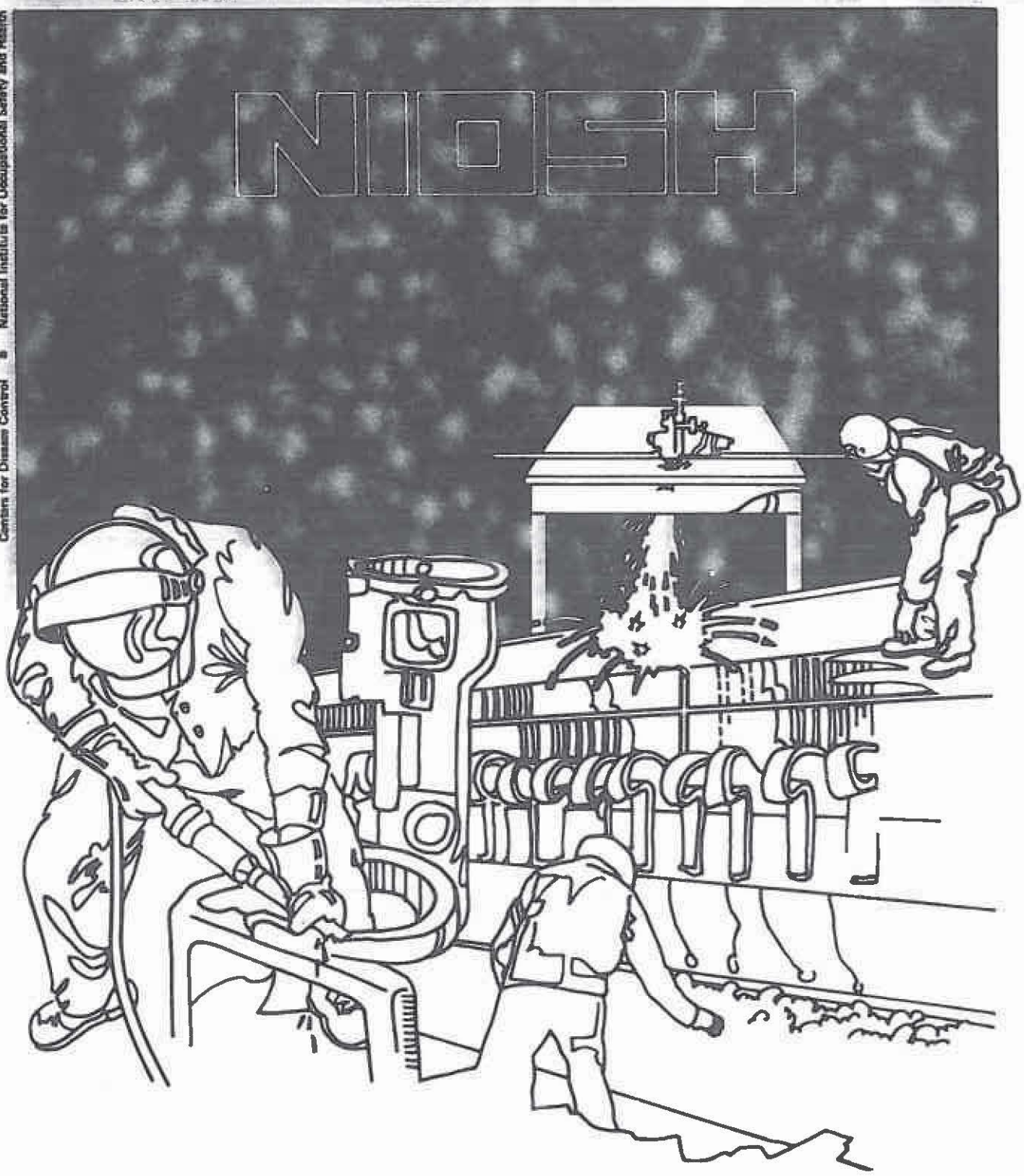

Health Hazard Evaluation Report

HETA 81-416-1334
TRAILWAYS BUS SYSTEM
DENVER, 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 81-416-1334
JULY 1983
TRAILWAYS BUS SYSTEM
DENVER, COLORADO

NIOSH INVESTIGATORS:
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I. SUMMARY

In August 1981, the National Institute for Occupational Safety Health (NIOSH) received a request to evaluate the exposures of baggage handlers and porters to bus diesel emissions at Trailways Bus Systems, Denver, Colorado. After the first survey, NIOSH also evaluated carbon monoxide exposures to Trailways' reservationists.

In July and September 1982, NIOSH investigators conducted an industrial hygiene survey to determine airborne concentrations of bus diesel exhaust emissions.

A total of eight area samples were taken for sulfur dioxide, nitrogen dioxide, total particulates, and formaldehyde. The maximum 8-hour time-weighted average (TWA) exposure concentrations for sulfur dioxide (range non-detectable to 0.18 mg/M^3) did not exceed the NIOSH criterion of 1.3 mg/M^3 or the OSHA standard of 13 mg/M^3. Nitrogen dioxide levels (range non-detectable to 0.07 mg/M^3) were also below NIOSH's criterion of 1.8 mg/M^3 and the OSHA standard of 9 mg/M^3. The total particulate results ranged from 0.01 to 0.09 mg/M^3 which was below the OSHA standard of 15 mg/M^3. All of the formaldehyde levels were non-detectable.

Ten samples were taken in the terminal area for carbon monoxide. An additional six carbon monoxide samples were taken in the reservationists room and ten in the parking garage area. Carbon monoxide levels in those areas where the baggage handlers work ranged from 20 to 40 ppm and 5 to 7 ppm in the package receiving department. These levels persisted for no more than 3 to 5 minutes while the buses were departing or arriving. Carbon monoxide levels in the reservationists room ranged from 7 to 35 ppm with the highest levels persisted for not longer than 15 minute periods. Carbon monoxide levels at the make-up air source to the building ranged from 7 to 350 ppm. The higher levels were dependent on automobile peak traffic flows in and around the make-up air source. All the levels in the reservationists room were below the 8 hour Time Weighted Average (TWA) limit for both the OSHA standard of 50 ppm and the NIOSH TWA criterion of 35 ppm.

On the basis of the environmental data collected, NIOSH concluded that a health hazard did not exist to the baggage handlers or the employees who work in the package receiving area during the study periods. NIOSH determined, however, that a potential health hazard existed to those employees who work in the reservation office. This is based on high carbon monoxide levels detected at the building's air make-up source as well as correspondingly high carbon monoxide levels in the reservationists room. Recommendations to further assist in preventing and/or controlling exposures are included in this report.

KEYWORDS: SIC 4171 (Terminal and Joint Terminal Facilities for Motor Vehicle Passenger Transportation), porters, baggage handlers, reservationists, 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 August 1981 from a representative of the employees at Trailways Bus Systems, Denver, Colorado. The request was to determine if there was a health hazard to porters/baggage handlers from diesel emissions which came from buses as they entered, exited, or sat running while at the Denver bus terminal. Normally, diesel emissions include combinations of sulfur dioxide, nitrogen oxides, and carbon monoxide, as well as other carbon compounds.

After the first evaluation NIOSH determined that Trailways' reservationists may also be exposed to automobile emissions which were thought to be potentially contaminating the make-up air to the building. This concern was further increased by health complaints described by the reservationists, e.g., eye, nose, and throat irritation.

Due to delays concerning legal right of entry NIOSH did not begin its first survey until July 1982 and finalized its evaluation in September 1982. The results of each investigation were presented to the company and employee representatives when they became available. A letter with a complete copy of the results was also presented to all the concerned parties in April 1983.

III. BACKGROUND

Trailways, Incorporated, Denver, Colorado, is affiliated with the national Trailways Bus System and operates 24 hours per day, 7 days per week. The Denver terminal has numerous departures and arrivals each day with the majority occurring in the morning, afternoon, and early evening. For each of the departures and arrivals, a group of baggage handlers are required to load or unload baggage and other packages. Other employees in this area include those who work in the package receiving department. These workers are responsible for moving packages to the appropriate destination.

During peak periods, numerous buses are coming and going into the Trailways terminal and emissions from these vehicles can become very high in and around this area. The problem is complicated further by emissions (both diesel and gasoline) which were coming from the Denver Regional Transportation District (RTD) buses that park next to the Trailways parking locations at the terminal. (During March 1983 RTD moved the majority [75%] of their buses from this terminal to a central location in downtown Denver.)

Other concerns which were described by the employees as creating irritations included Trailways buses which run continuously while in the terminal. This type of condition normally occurs in the winter or summer time and is primarily performed in order to maintain the buses interior temperature. Other complaints which created irritations to the employees who work in the terminal area were climatic conditions in the Denver area (i.e., inversion periods) which virtually eliminated air mixing/circulating of the emissions in the terminal area. Finally, it was reported to NIOSH that due to a lack of air handling devices (i.e., exhaust or diluting type ventilation systems in this area) that it was nearly impossible to reduce or eliminate the emissions. This was said to be especially true with the type of conditions described above.

After the first evaluation it was also determined that a potential health hazard from carbon monoxide may at various times exist to the Trailways' reservationists. This was considered because of complaints that were given to NIOSH concerning eye, nose, and throat irritation as well as unusual odors which commonly resembled auto exhaust. Upon further investigation it was determined that the ventilation ducts in a portion of the offices in and around the reservationists office were not operating effectively. It was also determined that the air make-up system to these rooms was located in a semi-closed garage and, therefore, could potentially be entraining automobile emissions during certain periods of the day.

IV. ENVIRONMENTAL DESIGN AND METHODS

A variety of sampling techniques were used to evaluate the suspected contaminants in this study. Environmental samples were taken in each of the areas of concern. The following is a description of the techniques used:

A. Sulfur Dioxide

Eight area samples were collected for sulfur dioxide on AA filters and the flow rate was set at 1.5 liters per minute (lpm). These samples were analyzed by NIOSH Method No. P&CAM 268.

B. Nitrogen Dioxide

Eight area samples were collected for nitrogen dioxide on long term detector tubes. The tubes were prepared using NIOSH Method No. P&CAM 231 and analyzed using a Perkin-Elmer>, Coleman 54B spectrophotometer.

C. Total Particulates

Eight area samples were collected for total particulates/nuisance dust on M-5 filters and the flow rate was set at 1.5 lpm. Total weights measurements were performed on an electrobalance by taking the difference in pre/post-tare weights.

D. Carbon Monoxide

Carbon monoxide levels were determined by using portable direct reading carbon monoxide analyzers. Ten area samples were taken in the terminal and the package receiving areas for 2 to 5 minute periods at different times of the day.

Six area samples were taken in the reservationists room for one hour periods and 10 area samples were also taken at the air make-up source for 30 minute periods.

E. Formaldehyde

Formaldehyde is an element found in trace amounts in diesel emissions. A total of ten formaldehyde samples were collected in impinger solutions. NIOSH Method No. P&CAM 125 was followed in the preparation of the impinger samples and analyzed using a Perkin-Elmer®, Coleman spectrophotometer.

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 of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, 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 medications 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. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

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 (TLV's), and (3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA 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 standards, by contrast, are based solely 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 legally required to meet only those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure 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.

The environmental and medical (Toxicological) evaluation criteria used for this investigation are presented in Table 1. Recommended environmental limits and general information concerning each substance are listed in this table, i.e., the source of the recommended limits, the present OSHA standard, and a brief description of the primary health effects known to date.

VI. ENVIRONMENTAL RESULTS AND DISCUSSION

Employee exposures to suspected airborne concentrations of sulfur dioxide, nitrogen dioxide, carbon monoxide, total particulates, and formaldehyde were evaluated. The following are the results of NIOSH's evaluation.

1. Sulfur Dioxide

The results received for sulfur dioxide are listed in Table 2. A total of eight area samples were taken in the terminal and package receiving areas. The sample results ranged from 0.03 to 0.19 mg/M^3 which is less than the NIOSH criterion of 1.3 mg/M^3 or the OSHA standard of 13 mg/M^3.

2. Nitrogen Dioxide

The nitrogen dioxide results are presented in Table 2. A total of eight area samples were collected in the terminal and package receiving area and all were non-detectable (ND).

3. Total Particulates

The total particulate (nuisance dust) results are presented in Table 2. The results for the eight samples ranged from 0.01 to 0.09 mg/M^3 which is far below the OSHA standard of 15 mg/M^3.

4. Formaldehyde

A total of eight samples were taken for formaldehyde and these are also presented in Table 2. All of the formaldehyde results were non-detectable.

5. Carbon Monoxide

The carbon monoxide results are presented in Tables 3 and 4. Table 3 shows the ten results received 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.

The levels of carbon monoxide measured in the reservationists room and at the air make-up source located in the parking garage area are presented in Table 4. 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 received in the reservationists 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 reservationists 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 Trailways' reservationists.

VII. CONCLUSIONS

Based on the environmental data collected by NIOSH 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 by NIOSH were relatively low for all the contaminants 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.

NIOSH was also not able to evaluate normal conditions and/or unusual conditions during the study period. That is, once NIOSH began its 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, NIOSH was also not able to sample during an inversion period nor while any buses were running in the terminal for extended periods of time do to inclement weather conditions (hot or cold periods) as described by the employees who work in this area.

NIOSH also concluded that a potential health hazard does exist to Trailways' 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 individuals at Trailways, 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., RTD's 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. Reservationists 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.

X. AUTHORSHIP AND ACKNOWLEDGMENTS

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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. Trailways Bus System.
2. U.S. Department of Labor/OSHA - Region VIII.
3. NIOSH - Region VIII.
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

Trailways Bus System
Denver, Colorado

Substance	Recommended Environmental Limit[A]	Reference Source	Primary Health Effects	OSHA Standard
Carbon Monoxide	35 ppm (C)200 ppm	NIOSH	Headaches; nausea; weakness; dizziness; confusion; loss of consciousness.	50 ppm
Sulfur Dioxide	1.3 mg/M^3	NIOSH	Irritation to eyes, nose, throat; choking; cough.	13 mg/M^3
Nitrogen Dioxide	1.8 mg/M^3	NIOSH	Cough; mucoid frothy sputum; dyspnea; chest pain; pulmonary edema; eye irritation.	9 mg/M^3
Total Particulate	10 mg/M^3	ACGIH	Considered an irritation to the eyes and mucous membrane.	15 mg/M^3
Formaldehyde	1.2mg/M^3	NIOSH*	Refer to notation listed below.	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.

TABLE 2

Summary of Air Samples for
Formaldehyde, Total Particulates, Sulfur and Nitrogen Dioxides

Trailways Bus System
Denver, Colorado

June 1982

Area Description	Sampling Time (minutes)		mg/M^3 Formaldehyde	Total Particulate	SO_2	NO_2
Package Receiving Area	360		ND	0.01	0.03	ND
Package Receiving Area	360		ND	0.03	0.04	0.07
Concourse-Lane 1	360		ND	0.07	0.18	ND
Concourse-Lane 5	360		ND	0.09	0.07	ND
Concourse-Lane 9	360		ND	0.03	0.04	ND
Concourse-Lane 1	360		ND	0.05	0.08	ND
Concourse-Lane 5	360		ND	0.07	0.10	ND
Concourse-Lane 9	360		ND	0.04	0.09	ND
EVALUATION CRITERIA:		NIOSH	1.2	----	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

TABLE 3

Summary of Air Samples for Carbon Monoxide

Trailways Bus System
Denver, Colorado

July 1982

Area Description	Sampling Time (minutes)	Range (ppm) Carbon Monoxide
Bus Arrival/Departures	5*	20-40
Bus Arrival/Departures	5*	20-40
Bus Arrival/Departures	5*	20-40
Bus Arrival/Departures	5*	20-40
Bus Arrival/Departures	5*	20-40
Package Receiving Area	2-3	5-7
Package Receiving Area	2-3	5-7
Background-Lane 1	5	6-10
Background-Lane 5	5	6-10
Background-Lane 9	5	6-10
EVALUATION CRITERIA:	NIOSH	35
	OSHA	50

ppm = parts per million

* = These samples were taken just prior to the buses arrival and/or departure and the sampling was completed approximately 2-3 minutes after the buses stopped or left the terminal.

TABLE 4

Summary of Air Samples for Carbon Monoxide

Trailways Bus System
Denver, Colorado

September 1982

Area Description*	Sampling Time	Range (ppm) Carbon Monoxide**
Building Air Inlet	6:00-6:30 AM	7-50
Building Air Inlet	6:30-7:00 AM	25-200
Building Air Inlet	7:00-7:30 AM	35-250
Building Air Inlet	7:30-8:00 AM	40-350
Building Air Inlet	8:00-8:30 AM	40-300
Reservation Room	6:00-7:00 AM	7-20
Reservation Room	7:00-8:00 AM	7-35
Reservation Room	8:00-9:00 AM	7-35
Building Air Inlet	3:30-4:00 PM	7-10
Building Air Inlet	4:00-4:30 PM	20-25
Building Air Inlet	4:30-5:00 PM	15-145
Building Air Inlet	5:00-5:30 PM	25-250
Building Air Inlet	5:30-6:00 PM	35-300
Reservation Room	3:00-4:00 PM	10-20
Reservation Room	4:00-5:00 PM	15-25
Reservation Room	5:00-6:00 PM	20-35
EVALUATION CRITERIA:	NIOSH	35
	OSHA	50

ppm = parts per million

* = The building make-up air inlet point where the carbon monoxide monitoring was performed was located inside an enclosed garage and cars were able to park directly next to this location.

** = Indicates the lowest and highest level during that sampling period.

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