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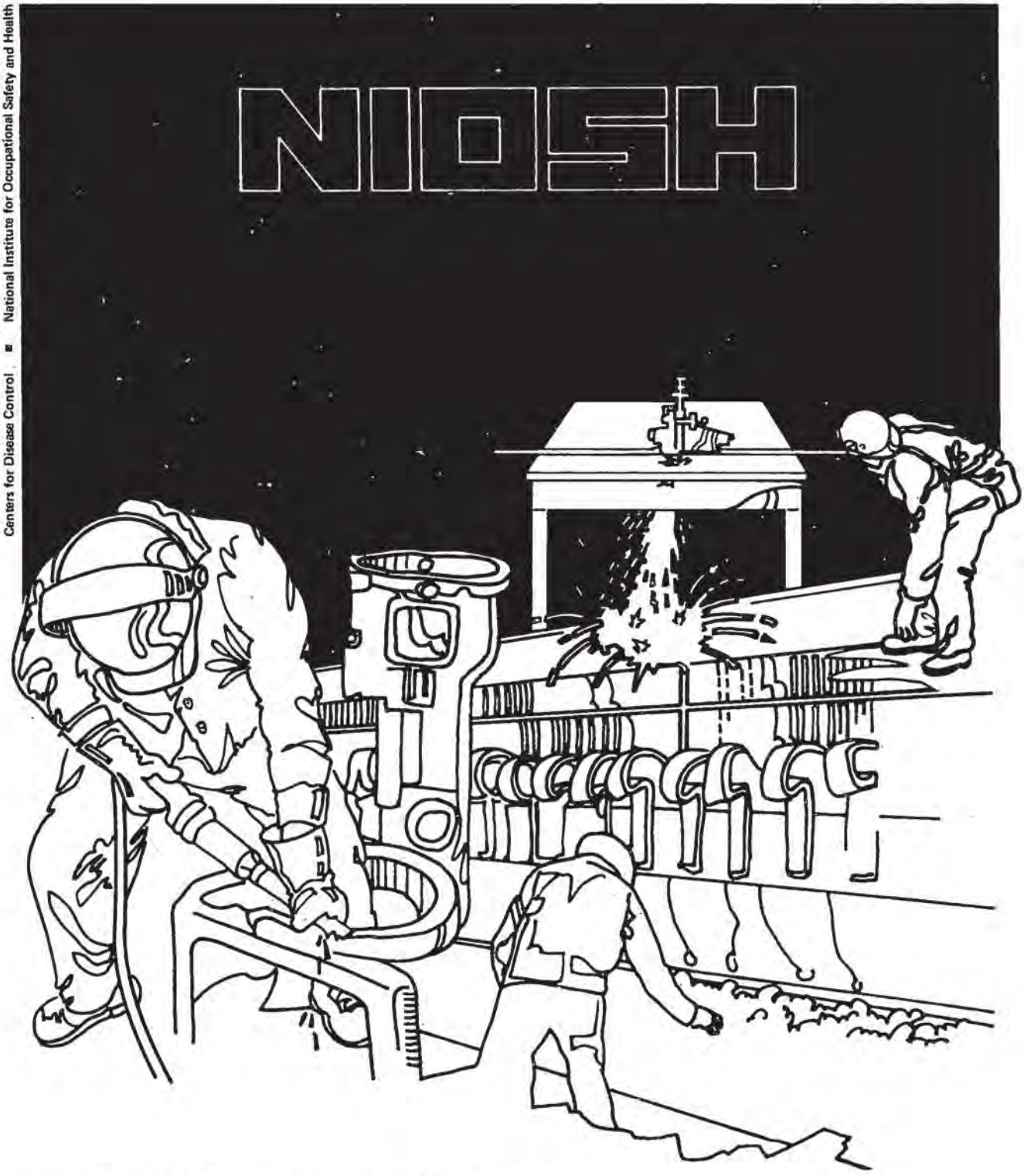

# Health Hazard Evaluation Report

HETA 83-145-1330
FRONTIER AIRLINES
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 83-145-1330
JUNE 1983
FRONTIER AIRLINES
DENVER, COLORADO

NIOSH INVESTIGATORS:
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## 1. SUMMARY

In February 1983, the National Institute for Occupational Safety and Health (NIOSH) received a request from management of Frontier Airlines to evaluate a potential health hazard to baggage handlers at the Denver Bag Transfer Point, Stapleton International Airlines, Denver, Colorado. One employee had developed chest pains when there was heavy traffic from the gasoline powered tractors delivering baggage to this point.

On March 8-10, 1983, NIOSH investigators conducted an environmental survey. Hourly and eight-hour time-weighted average (TWA) air samples were taken for carbon monoxide (CO) at the Frontier Airlines work station at the Denver Bag Transfer Point and approximately 50 yards from this station. Results of this testing showed average background levels of CO of 10 ppm. When the gasoline powered tractors arrived with baggage, levels went up to as high as 100 ppm but again returned to 15-20 ppm within 15 seconds. All of the Frontier tractor drivers turned off their engines immediately upon arrival at the baggage transfer point. All of the other airlines left their tractor engines running; this latter factor accounted for most of the elevated CO levels observed during this evaluation. Eight-hour TWAs ranged from 29 to 35 ppm. The highest one-hour average was 75 ppm. CO measurements were also made in the ramp area; levels were from 10 to 15 ppm. The NIOSH recommended level for 8-hour TWA is 35 ppm. The Occupational Safety and Health Administration (OSHA) standard is 50 ppm.

A medical study was conducted on April 19, 1983. The individual exposures to carbon monoxide (CO) were monitored by following carboxyhemoglobin (COHb) concentration as determined by concentration of CO in the expired air after 20-second breath holding. Workers initially included in the study were tested before they started work about 7 A.M., after the morning rush (after 9 A.M.), and after the late morning rush (after 11:30 A.M.). The one worker in the Denver Bag area was also tested shortly before the late morning rush. Other workers were added after the morning rush. Workers were also asked about smoking, CO exposures, and current symptoms. Testing was performed in an office by the entrance to the Bag Room with background readings taken throughout the test period. Two environmental readings were also taken in each of the Bag Room and the Denver Bag area during the morning rush.

On the day of the medical study workers in the baggage area were exposed to CO levels above background but not high enough to cause problems in otherwise healthy individuals. Exposures in the Denver Bag area are somewhat higher than in the Bag Room giving a maximum COHb level of 3.8%. The recommended limit is 5% COHb for non-smokers. By history exposures in this area did cause problems in at least one individual, although he probably had a somewhat compromised heart which contributed to the problem. Shutting of the engine while unloading the baggage has significantly reduced the CO exposure in the area.

On the basis of the environmental and medical data obtained in this investigation, NIOSH concluded that a potential health hazard does exist to workers in the vicinity of the Denver Bag Transit Point. If other airlines would turn off their engines when transferring baggage, this would eliminate the possibility of a health hazard from carbon monoxide. Recommendations for decreasing CO exposures are included in this report.

KEYWORDS: SIC 4511 (Air Transportation, Certificated Carriers), carbon monoxide, baggage handlers.

## II. INTRODUCTION

In February 1983 the National Institute for Occupational Safety and Health (NIOSH) received a request from management of Frontier Airlines to evaluate a potential health hazard to baggage handlers at the Denver Bag Transfer Point, Stapleton International Airlines, Denver, Colorado. Frontier management requested this evaluation after one employee at the Transfer Point developed chest pains during peak traffic while working in an area where gasoline powered tractors delivered baggage.

On March 8-10, 1983, NIOSH investigators conducted an environmental survey; the medical evaluation was performed on April 19, 1983. In April 1983 results were discussed with management and in early May all workers participating in the evaluation were sent a letter informing them of the environmental and medical results.

## III. BACKGROUND

The Denver Bag Transfer Point at Stapleton International Airport is underneath the airport terminal. In this area baggage is taken from a small trailer pulled by a gasoline powered tractor and placed on conveyor belts and transferred to baggage carrousels for passenger pickup.

## IV. EVALUATION DESIGN AND METHODS

### A. Environmental

Carbon monoxide air samples were collected for an 8-hour period using a calibrated carbon monoxide monitor and strip chart recorder. This monitor was calibrated each morning and when it was turned off in the afternoon. This monitor also was used to check CO levels in the ramp area.

### B. Medical

The medical study was conducted on April 19, 1983. The workers exposures to carbon monoxide (CO) were monitored by following carboxyhemoglobin (COHb) concentration as determined by concentration of CO in the expired air after 20-second breath holding. Workers initially included in the study were tested before they started work about 7 A.M., after the morning rush (after 9 A.M.), and after the late morning rush (after 11:30 A.M.). The one worker in the Denver Bag area was also tested shortly before the late morning rush. As other workers heard about the study they wished to be included, and so were added after the morning rush. Testing was done in an office by the entrance to the Bag Room with background readings taken throughout the test period. Two environmental readings were also taken in each of the Bag Room and the Denver Bag area during the morning rush.

In addition to COHb determinations, workers were asked about smoking, CO exposures, and current symptoms. Table I gives number of workers seen by work area along with COHb levels.

Alveolar CO concentrations were determined by having the worker take a deep breath, hold it for at least 20 seconds (timed), exhale about half the air and breathe the rest into a milar bag. The CO in the exhaled air was then analyzed using a Ecolyzer® CO Analyzer. Parts per million (ppm) CO in the expired air was converted to % COHb of total hemoglobin utilizing the formula:

$$\% \text{ COHb} = 2.7566 \times \sqrt{\text{CO} + 14.3105} - 11.8727$$

## 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.

| | Permissible Exposure Limits 8-Hour Time-Weighted Exposure Basis |
|---|---|
| Carbon monoxide..... | 35 ppm (NIOSH)<br>50 ppm (OSHA) |

ppm = parts of vapor or gas per million parts of contaminated air by volume.

B. Toxicological

Carbon Monoxide[1,2,3], -- The signs and symptoms of carbon monoxide (CO) poisoning may include headache, nausea, vomiting, dizziness, drowsiness, and collapse. Carbon monoxide rapidly binds to the oxygen-carrying molecule of the red blood cells, hemoglobin, forming "carboxyhemoglobin" (COHb). When CO binds with hemoglobin to form COHb, it reduces the oxygen-carrying capacity of the blood. The more COHb is formed, the more significant the symptoms are. Heart disease may be made worse in workers who have coronary heart disease and are exposed to CO, particularly concentrations high enough to produce a COHb level greater than 5% of total hemoglobin (referred to as % saturation). There is also important evidence that exposure to lower CO concentrations, producing COHb levels below 5%, affects the nervous system and causes changes in visual alertness, response time, and fine judgment.

Exposure at the current OSHA standard for CO of 50 ppm 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 CO 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.

Non-smoking, non-exposed persons have an average COHb level of 1%. Non-smokers exposed to 50 ppm (50 parts per million of CO, the OSHA standard) for six to eight hours have COHb levels of 8 to 10%. NIOSH recommends 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%. Symptoms such as headache and nausea may be seen above 15% saturation, but usually not at lower levels. At 25%, there may be electrocardiographic evidence of heart effects, and 40% usually results in collapse.

These recommendations do not consider the smoking habits of workers since the COHb levels in smokers has generally been found to be 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 then are exposed in a work place with an average concentration of 35 ppm will have a total COHb of about 10%.

Although CO binds to the hemoglobin over 200 times as strongly as does oxygen, when exposure ceases the CO will slowly be replaced by oxygen from the air restoring the oxygen carrying capacity of the hemoglobin. Even with fairly severe exposures, prompt removal to fresh air (oxygen if available) will usually be followed by complete recovery.

## VI. RESULTS AND DISCUSSION

On March 8-10, 1983, NIOSH investigators conducted an environmental survey. Hourly and eight-hour time-weighted average (TWA) air samples were taken for carbon monoxide (CO) at the Frontier Airlines work station at the Denver Bag Transfer Point and approximately 50 yards from this station. Results of this testing showed average background levels of CO of 10 ppm. When the gasoline powered tractors arrived with baggage, levels went up to as high as 100 ppm but again returned to 15-20 ppm within 15 seconds. All of the Frontier tractor drivers turned off their engines immediately upon arrival at the baggage transfer point. All of the other airlines left their tractor engines running; this latter factor accounted for most of the elevated CO levels observed during this evaluation. Eight-hour TWAs ranged from 29 to 35 ppm. The highest one-hour average was 75 ppm. CO measurements were also made in the ramp area; levels were from 10 to 15 ppm. The NIOSH recommended level for 8-hour TWA is 35 ppm. The Occupational Safety and Health Administration (OSHA) standard is 50 ppm.

The medical evaluation was performed on April 19, 1983. On the day of the study CO levels were somewhat elevated (mean 9.7 ppm) in the office where the tests were done. This partly explains the somewhat elevated before-work COHb levels in the non-smoking workers tested (mean 2.7% COHb). Auto exhaust exposures while driving to work may also have contributed to these levels. During the morning a breeze picked up; so in spite of increased activity about the Ramp, the levels in the test room dropped. The low point (mean 4.5 ppm CO) was during the less active period between the morning rush and the late morning rush. Both COHb levels and air CO levels are shown in Table 1.

In spite of a decided decline in outside CO levels, most workers' COHb levels remained fairly steady. This suggests that they were receiving some CO exposure on the job. COHb levels were not high enough to produce symptoms in healthy workers.

The worker in Denver Bag area did show a decided increase in COHb level (from 2.3% to 3.8%) over the late morning rush. The Denver Bag area is more sheltered from any outside breeze and more confined. Background readings in the area earlier in the day had showed a doubling of CO air levels briefly when a baggage cart was brought into the area. With increased activity, and several airlines other than Frontier failing to shut off engines while unloading, background levels would rise. This is the area where one worker developed symptoms suggestive of angina pectoris prompting this study. Although that particular worker no longer worked in the area, it is probable that his problem stemmed from decreased physical stamina due to a compromised heart, decreased oxygen carrying capacity of his blood due to CO exposure (no one shut off engines at that time), and an increased demand on heart and oxygen carrying capacity due to hard physical labor.

## VII. CONCLUSIONS

Workers in the baggage area are exposed to CO levels above background but not high enough to cause problems in otherwise healthy individuals. Exposures in the Denver Bag area are somewhat higher than in the Bag Room and by history did cause problems in at least one individual, although he probably had a somewhat compromised heart which contributed to the problem. Shutting of the engine while unloading the baggage has significantly reduced the CO exposure in the area.

## VIII. RECOMMENDATIONS

Shutting off the engine while unloading baggage in the Denver Bag area should be required of all airlines as a cheap, easily applied method of eliminating unnecessary CO exposure. An alternative would be to install an exhaust system, but this would be considerably more expensive.

## IX. REFERENCES

1. National Institute for Occupational Safety and Health. Criteria for a Recommended Standard--Occupational Exposure to Carbon Monoxide. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1973. (DHEW Publication No. (NIOSH) 73-11000).

2. Proctor, N.H., Hughes, J.P. Chemical Hazards of the Workplace. Philadelphia: J.B. Lippincott Company, 1978.

3. National Institute for Occupational Safety and Health. NIOSH/OSHA Occupational Health Guidelines for Chemical Hazards. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1981. (DHHS Publication No. (NIOSH) 81-123).

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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. Frontier Airlines.
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

Carboxyhemoglobin (COHb) Levels By Work Area and Time of Day

Frontier Airlines
Denver, Colorado

April 19, 1983

| Work Area | Time of Day | Number of Workers Tested | COHb Level (%) Mean | COHb Level (%) Range | Breath CO Mean (ppm) |
|---|---|---|---|---|---|
| Denver Bag | 6:30- 7:30 | 1 | 2.3 | --- | 12 |
| | 9:00-10:00 | 1 | 2.3 | --- | 12 |
| | 10:01-11:00 | 1 | 2.3 | --- | 12 |
| | 11:30+ | 1 | 3.8 | --- | 18 |
| Bag Room* # | 6:30- 7:30 | 4 | 2.9 | 2.5- 3.8 | 14.5 |
| | 9:00-10:00 | 5 | 2.7 | 2.5- 3.1 | 13.6 |
| | 11:30+ | 5 | 2.6 | 2.0- 3.1 | 13.2 |
| Ramp* | 9:00-10:00 | 1 | 3.8 | --- | 18 |
| | 11:30+ | 1 | 4.0 | --- | 19 |
| Concourse | 6:30- 7:30 | 1 | 2.3 | --- | 12 |
| | 11:30+ | 1 | 2.0 | --- | 11 |
| Smokers* | 9:00-10:00 | 2 | 9.5 | 7.7-11.2 | 46.0 |
| | 10:01-11:00 | 1 | 8.6 | --- | 41 |
| | 11:30+ | 2 | 7.2 | 6.1- 8.3 | 33.5 |
| Environmental Readings in parts CO per million parts contaminated air (ppm) | | | | | |
| Testing Office | 6:30- 7:30 | 6 | 9.7 | 7 -12 | |
| | 9:00-10:00 | 9 | 6.8 | 4 -10 | |
| | 10:01-11:00 | 2 | 4.5 | 4 - 5 | |
| | 11:30+ | 10 | 5.6 | 5 - 8 | |
| Denver Bag | 8:30 | 1 | 10 | with no activity when | |
| | | 1 | 19 | baggage cart pulled up and shut off motor | |
| Bag Room | 8:25 | 2 | 13 | both | |

* Smokers not included by work area. For the 9:00-10:00 tests the smoker with the lower value had smoked 3-4 cigarettes before being seen and the one with the higher value had smoked 8. For the 10:01-11:00 test 2 cigarettes had been smoked since the previous test. For the 11:30+ tests, the smoker with the lower value had not smoked since the first tests and the other smoker had smoked 2-3 cigarettes since the 10:01-11:00 test.

\# Two workers in the Bag Room also spent some of their time on the Ramp.

Note: A breeze picked up mid-morning and continued the rest of the testing period.

TABLE 2

8-Hour Time-Weighted Average and Hourly Averages of
Carbon Monoxide (CO) Concentrations at
Denver Bag Transfer Point
Stapleton International Airport

Frontier Airlines
Denver, Colorado

March 8-10, 1983

| Date | Time of Sample | Carbon Monoxide ($mg/M^3$) Hourly Average Station A | Station B |
|---|---|---|---|
| March 8 | 7:30 AM | 15 | 20 |
| | 8:30 AM | 25 | 25 |
| | 9:30 AM | 35 | 30 |
| | 10:30 AM | 35 | 35 |
| | 11:30 AM | 35 | 40 |
| | 12:30 PM | 35 | 40 |
| | 1:30 PM | 40 | 50 |
| | 2:30 PM | 50 | 40 |
| | TWA Average | 29.0 | 35.0 |
| March 9 | 7:30 AM | 25 | 30 |
| | 8:30 AM | 30 | 15 |
| | 9:30 AM | 15 | 45 |
| | 10:30 AM | 20 | 15 |
| | 11:30 AM | 25 | 20 |
| | 12:30 PM | 75 | 45 |
| | 1:30 PM | 60 | 40 |
| | 2:30 PM | 35 | 25 |
| | TWA Average | 35.5 | 29.0 |
| March 10 | 6:30 AM | 20 | * |
| | 7:30 AM | 40 | * |
| | 8:30 AM | 35 | * |
| | 9:30 AM | 20 | * |
| | 10:30 AM | 15 | * |
| | 11:30 AM | 50 | * |
| | 12:30 PM | 40 | * |
| | TWA Average | 31.0 | * |

EVALUATION CRITERIA: 35 ppm (NIOSH)
50 ppm (OSHA)

LABORATORY LIMIT OF DETECTION: 1 ppm

* = carbon monoxide monitor was not working

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