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TECHNICAL ASSISTANCE REPORT
TA 79-25

DETROIT CANADA TUNNEL
DETROIT, MICHIGAN

February 1980

I. SUMMARY

The Hazard Evaluation and Technical Assistance Branch of the National Institute for Occupational Safety and Health (NIOSH) conducted an environmental survey at the Detroit Canada Tunnel in Detroit, Michigan, on August 18-20, 1979. Environmental measurements were made to determine employee exposures to: carbon monoxide, lead, sulfuric acid, total particulate, benzene, and noise. Employees were also given pre- and post-shift carboxyhemoglobin (COHb) tests.

Time-weighted-average (TWA) exposure levels for carbon monoxide as determined by personnel sampling using long term detector tubes ranged from 1 ppm to 10 ppm. (NIOSH recommends a 8-hour TWA of 35 ppm.) Carbon monoxide sampling conducted at two of the inspection lanes using Ecolyzers equipped with recorders showed hourly average carbon monoxide concentrations ranging from 4 ppm to 40 ppm.

The test results for COHb showed that on August 18 the non-smoking employees' average COHb levels increased by 3.5% from pre- to post-shift, with the average post-shift level being 6.3%. On August 20, the average COHb level increased by 0.7% from pre- to post-shift testing, resulting in an average post-shift level of 4.9%. Smokers' COHb average post-shift levels were 7.5% and 8% on the respective days, an increase of 2% and 1.5% from pre shift levels.

Sample results indicated no detectable levels of sulfuric acid and very low concentrations of benzene (0.02 ppm), total particulate (0.08 mg/M^3) and lead (0.005 mg/M^3). Noise levels, as determined by dosimeter readings, were well within recommended levels.

Based on the information collected during the time of this evaluation, no health hazard existed to inspectors under the current methods of operation. Results do indicate that although carbon monoxide exposures were not in excess of recommended levels, an increase in COHb levels occurred during the shifts. Even though these increases were not excessive, the practice of rotating inspectors should be continued so as not to unduly expose these individuals.

II. INTRODUCTION

At the request of the Animal and Plant Inspection Service, U.S. Department of Agriculture, NIOSH conducted a survey at the Detroit Canada Tunnel. The purpose of the survey was to determine if employee exposures to auto emissions during routine inspection tasks posed a health problem. Of major concern was exposure to carbon monoxide. Because traffic is heavier during certain portions of each day as well as during the summer months and on weekends, the time of this evaluation, the weekend of August 18, 1979, was selected for peak traffic density.

III. BACKGROUND

The Detroit Canada Tunnel has 5 primary inspection lanes as well as secondary inspection areas and an administration building. The number of primary inspection lanes open to traffic at any time depends upon the time of day, day of the week, time of the year and traffic density. Number 1 lane is normally open on a 24 hour basis and also handles any truck and bus traffic.

The principal employees at the inspection facility are inspectors from the Immigration and Naturalization Service of the U.S. Department of Justice and inspectors from the Bureau of Customs of the U.S. Department of the Treasury. The inspectors rotate on a half-hour basis so that the maximum time that any one inspector would have to spend at the primary lines would be approximately four hours per day. The remainder of the day is spent in the secondary inspection areas or the administration building.

IV. EVALUATION DESIGN AND METHODS

Personal sampling for carbon monoxide was conducted using Drager* long term detector tubes. A discoloration of the sorbent in the tube indicates the presence of carbon monoxide and the length of stain corresponds to the concentration. Carbon monoxide Ecolyzers*, equipped with recorders, were placed in Lane 1 and Lane 2 inspection booths. The sampling tubes for the Ecolyzers were positioned to sample air that corresponded to the inspectors' breathing zones. Lead, total particulate, sulfuric acid, and benzene samples were collected in a similar manner in Lane 1 and Lane 2. Samples for lead were collected on filters and analyzed using standard atomic absorption techniques. Samples for benzene were collected on charcoal tubes and analyzed by gas chromatographic methods. Sulfuric acid samples were taken on filters and analyzed by ion chromatography. Total particulate was determined by gravimetric methods using filters as collection media. Noise exposures were measured using Dupont* dosimeters.

Pre-shift and post-shift carboxyhemoglobin levels on the inspectors were determined using an Ecolyzer Carboximeter*. This instrument is designed to measure the concentration of carbon monoxide in a breath sample introduced into its intake port. The carbon monoxide level is displayed on the meter as % COHb in the blood.

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*Mention of commercial name or products does not constitute endorsement by NIOSH.

V. EVALUATION CRITERIA

Carbon monoxide is classified as a chemical asphyxiant whose toxic effects are a direct result of the hypoxia (lack of oxygen) produced by a given exposure. Carbon monoxide is rapidly transferred in the lungs from the inhaled air to the blood. The carbon monoxide is reversibly bound to hemoglobin in the red blood cells forming carboxyhemoglobin. Hemoglobin has 200 times more affinity for carbon monoxide than oxygen. Symptoms will vary according to the COHb saturation level, measured in %. Symptoms may include headache, nausea, vomiting, dizziness, drowsiness, and collapse. Individuals with coronary heart disease are believed to be especially sensitive to elevated levels of COHb. Studies have also indicated that chronic exposure to carbon monoxide may result in cardiovascular alterations in persons with coronary heart disease or underlying coronary heart problems.

NIOSH recommends that no worker be exposed to concentrations of carbon monoxide greater than 35 ppm as determined by a time-weighted-average (TWA) exposure and that concentration of carbon monoxide not exceed a ceiling concentration of 200 ppm. A worker continuously exposed to the 35 ppm allowable concentration would not be expected to have a COHb level in excess of 5%. It should, however, be noted that the recommended levels do not take into consideration the smoking habits of the worker.

Occupational health standards for total particulate, sulfuric acid, lead, benzene and noise are as follows:

	NIOSH	OSHA
Total particulate	10 mg/M^3	15 mg/M^3
Lead	0.1 mg/M^3	0.1 mg/M^3
Benzene	1 ppm	10 ppm
Sulfuric acid	1 mg/M^3	1 mg/M^3
Noise	90 dBA	90 dBA

where mg/M^3 refers to milligrams of contaminant per cubic meter of air, ppm refers to parts of contaminant per million parts of air by volume and dBA refers to decibel level as determined using the A-weighted sound level scale. Exposures should not be exceeded on an 8-hour TWA basis.

VI. RESULTS AND DISCUSSION

The hourly average carbon monoxide concentrations in inspection Lanes 1 and 2 as measured by the Ecolyzers are presented in Figures 1 and 2. Examination of these figures show that on one occasion, the hourly average carbon monoxide level exceeded 35 ppm, but that the time-weighted average concentration for any 8-hour time period was considerably less than 35 ppm. In addition, the inspectors' average exposure for their workday would be expected to be less than the time-weighted 8-hour average concentration at the inspection booths since the inspectors generally work no more than 4 hours per day at the inspection booths. The personnel samples collected on the inspectors show this to be true. The TWA concentration as measured by long term detector tubes ranged from 1 ppm to 10 ppm (Table 1).

The test results for COHb showed that on August 18, the non-smoking employees' average COHb levels increased by 3.4% from pre- to post-shift, with the average post shift level being 6.3% (range 1%-9%)(Table 2). On August 20, the average COHb level increased by 0.7% from pre to post shift testing, resulting in an average post-shift level of 4.9% (range 4.4%-5.5%) (Table 3). Smokers' COHb average post-shift levels were 7.5% and 8% on the respective days, an increase of 2% and 1.5% from pre- to post-shift testing. The results indicate that the inspectors were being exposed to carbon monoxide while at work. It is difficult to single out and rank individual sources of carbon monoxide in order of importance. However, carbon monoxide in ambient air and carbon monoxide from cigarette smoke are not additive in regards to biological effects. Studies have shown that smoking habits of workers have a tremendous bearing on their actual daily exposure to carbon monoxide. Smokers, in fact, are less susceptible to increases in COHb due to exposure to low concentrations of carbon monoxide, since their levels of COHb, already high, would not be increased by the exposure. This appears to be true of the smokers evaluated in this study. Their COHb levels are higher than expected when the measured environmental carbon monoxide levels are considered. The non-smoker COHb levels are a result of workplace exposure to carbon monoxide. Again, the measured COHb levels are slightly higher than expected when considering the carbon monoxide levels measured in the inspection lanes. This slight elevation in COHb above that expected as a result of measured ambient carbon monoxide exposures could be a result of the non-smoking inspectors spending time with smokers in rather confined areas, resulting in increased carbon monoxide exposure which would not be associated with inspection lane concentrations.

In addition to carbon monoxide concentration, measurements were made to determine the inspectors' personal noise exposures. The dosimeters used to make the measurements give the actual exposure during the workday as a percentage of that permitted in the OSHA regulations (90 dBA). Six measurements were made on August 18 and six on August 20. Of the twelve measurements made, nine showed zero percent exposure. The remaining three showed exposures of 0.5%, 1%, and 3%. All readings were low compared to the 100% allowable exposure.

Environmental measurements for lead, total particulate, sulfuric acid and benzene were collected in Lane 1 and Lane 2 on both August 18 and August 20. No sulfuric acid was detected. Total particulate concentrations were 0.08 mg/M^3 on August 18 and non-detectable levels were found on August 20. A lead concentration of 0.005 mg/M^3 was measured in Lane 1 on August 18. All other samples for lead had non-detectable levels. All four samples collected for benzene showed concentrations of 0.02 ppm. Concentrations for the four substances were all within permissible exposure levels.

TABLE I

CARBON MONOXIDE CONCENTRATIONS

DETROIT CANADA TUNNEL
DETROIT, MICHIGAN

August 18, 1979

Inspector	Sample Time	Carbon Monoxide Concentrations (ppm)
1	1535 - 2326	7
2	1537 - 2322	8
3	1538 - 2326	8
4	1541 - 2324	8
5	1543 - 2328	7
6	1606 - 2331	8
7	1615 - 2314	2
8	1600 - 2325	6

August 20, 1979

1	0753 - 1543	2
2	0755 - 1500	1
3	0758 - 1547	9
4	0815 - 1205	N.D.*
5	0816 - 1537	10
6	0822 - 1543	4
7	0835 - 1543	7

* Not detected

VII. RECOMMENDATIONS

1. The practice of rotating inspectors should be continued to help minimize exposure.

2. Carbon monoxide levels should be periodically measured.

VIII. AUTHORSHIP AND ACKNOWLEDGEMENTS

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IX. REFERENCE

1. Criteria for a Recommended Standard . . . Occupational Exposure to Carbon Monoxide; U.S. Department of HEW, Public Health Service, Center for Disease Control, HSM 73-11000, 1972.

X. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this report are currently available, upon request, from NIOSH, Division of Technical Services, 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 22161.

Copies of this report have been sent to:

1) U.S. Department of Agriculture, Washington, D.C.
2) U.S. Department of Labor, Region V.
3) NIOSH, Region V.

TABLE II

CARBOXYHEMOGLOBIN LEVELS

DETROIT CANADA TUNNEL
DETROIT, MICHIGAN

August 18, 1979

Employee	% Carboxyhemoglobin		Δ % COHb
	Pre-Shift	Post-Shift	
Immigration (1)	2.6	6.4	+ 3.8
Immigration (2)*	4.3	7.5	+ 3.2
Immigration (3)*	8.5	9.0	+ 0.5
Immigration (4)	3.4	7.1	+ 3.7
Immigration (5)	3.4	6.2	+ 2.8
Immigration (6)*	2.4	6.6	+ 4.2
Immigration (7)	2.3	1.0	- 1.3
Customs (1)	2.6	5.1	+ 2.5
Customs (2)	2.8	5.2	+ 2.4
Customs (3)*	8.7	9.0	+ 0.3
Customs (4)	3.1	6.0	+ 2.9
Customs (5)*	3.0	5.5	+ 2.5
Customs (6)	2.5	5.9	+ 3.4
Customs (7)	3.8	4.5	+ 0.7
Customs (8)	2.7	5.3	+ 2.6
Non-Smokers' Average	2.9	6.3	+ 3.4
Smokers' Average	5.4	7.5	+ 2.1

* Smoker

TABLE III

CARBOXYHEMOGLOBIN LEVELS

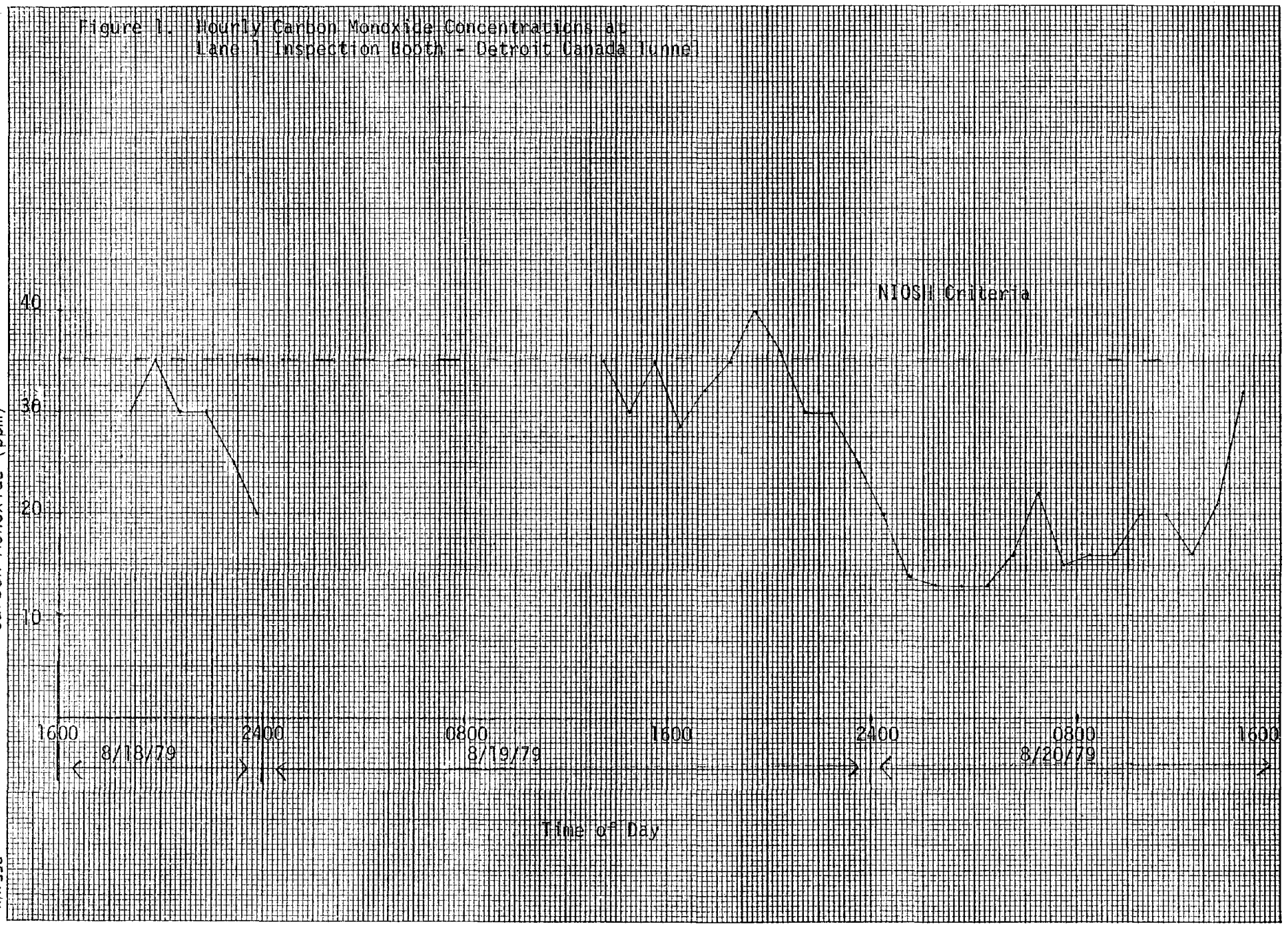
DETROIT CANADA TUNNEL
DETROIT, MICHIGAN

August 20, 1979

Employee	% Carboxyhemoglobin		Δ % COHb
	Pre-Shift	Post-Shift	
Immigration (1)*	7.5	9.0	+ 1.5
Immigration (2)	4.4	5.3	+ 0.9
Immigration (3)*	8.0	7.0	- 1.0
Immigration (4)	3.6	4.6	+ 1.0
Immigration (5)	4.4	5.5	+ 1.1
Immigration (6)	3.5	4.2	+ 0.7
Immigration (7)	4.4	5.3	+ 0.9
Customs (1)*	7.0	-	-
Customs (2)	4.8	4.8	0
Customs (3)	3.3	4.4	+ 1.1
Customs (4)*	3.5	8.2	+ 4.7
Customs (5)	5.4	-	-
Non-Smokers' Average	4.2	4.9	+ 0.7
Smokers Average	6.5	8.0	+ 1.5

* Smoker

Figure 1. Hourly Carbon Monoxide Concentrations at Lane 1 Inspection Booth - Detroit Canada Tunnel



BEE M/M

FIGURE 2. Four-Hour Carbon Monoxide Concentrations at Lane 2, Inspection Booth
Detroit, Canada Tunnel