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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE  
CENTER FOR DISEASE CONTROL  
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH  
CINCINNATI, OHIO 45202

HAZARD EVALUATION AND TECHNICAL ASSISTANCE  
REPORT NO. TA 79-2

DEPARTMENT OF TRANSPORTATION  
VEHICLE INSPECTION STATIONS  
WASHINGTON, D.C.

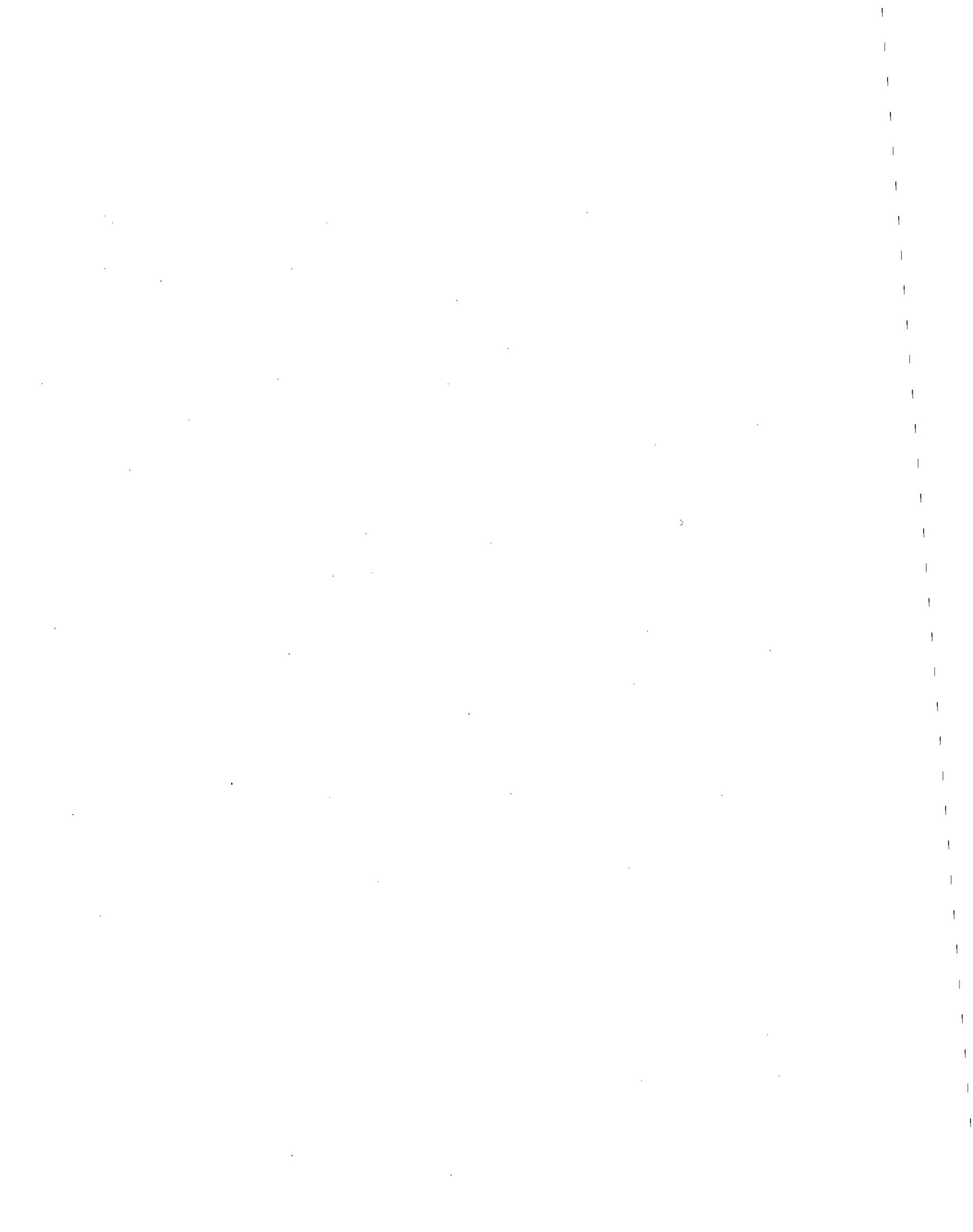
APRIL 1979

Study Requested By:

Office of Administration  
Department of Transportation  
Government of the District of Columbia

Report Prepared By:

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Industrial Hygiene Section, HETAB, DSHEFS



## 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 NE and the SW Vehicle Inspection Stations, Washington, D.C. on November 7 and 8, 1978. Atmospheric samples were collected to determine employee exposures to: carbon monoxide, lead, asbestos, hydrogen sulfide and sulfur dioxide. Pre- and post-shift carboxyhemoglobin levels were obtained using a carbon monoxide breath analysis technique.

No detectable levels of asbestos, hydrogen sulfide, or sulfur dioxide were found at either inspection station. Lead levels were less than one-tenth of the current OSHA standard (0.20 mg/M<sup>3</sup>) and less than one-fifth of the NIOSH recommended standard (0.10 mg/M<sup>3</sup>) at the SW station. There were no detectable levels of lead found at the NE station.

Time-weighted-average exposure levels for carbon monoxide were less than applicable health standards in the NE station but equal to the NIOSH recommended standard of 35 ppm for 4 of the 9 inspectors at the SW station. The NIOSH ceiling level of 200 ppm was exceeded frequently for short time periods (<30 sec) at both inspection stations. Levels as high as 400-500 ppm were obtained in the vicinity of the "sticker" position which is the last stop before the vehicle leaves the building.

Recommendations concerning work practices, medical monitoring and more efficient utilization of the existing exhaust ventilation systems are presented in this report.

## II. INTRODUCTION AND PURPOSE

At the request of the Office of Administration, Department of Transportation, Government of the District of Columbia, the National Institute of Occupational Safety and Health (NIOSH) conducted a survey of the SW and the NE Vehicle Inspection Stations in Washington, D. C. The purpose of the survey was to determine if employee exposures to auto emissions during their routine inspection tasks are potentially harmful. Of major concern was exposure to carbon monoxide, however, due to their high degree of toxicity, exposures to lead and asbestos were also evaluated. This survey will also evaluate the effectiveness of the newly installed ventilation systems.

## III. ENVIRONMENTAL EVALUATION

### A. Process/Facility Description

The District of Columbia requires that all vehicles registered by the District be inspected at least once per year. The inspections are performed at two motor vehicle inspection stations. One station is located in the southwest part of D.C., and the other is located in the northeast section. Both are brick buildings, completely enclosed with

doors at each end for vehicles to enter and exit. Both buildings have four inspection lanes - only three are used for routine inspection purposes. Lane usage will fluctuate from 2 to 3 lanes during the day depending on the number of cars waiting for inspection. There are usually 9 inspectors (3 each lane) and 2 supervisors on duty at each station each working daily (Monday through Friday, 7:30 a.m. until 4:00 p.m.). Each man has two 15-minute breaks in the morning, two 15-minute breaks in the afternoon and a lunch break. Inspectors are rotated through all work stations.

Automobiles enter the building and stop at the first inspection point. The driver gets out of the car and proceeds to the other end of the building. The tasks at the first inspection point include checking the lights, horn, front-end and wheel alignment, tires, exhaust system, etc. An inspector drives the car to the midpoint of the inspection lane where the breaks are sharply applied at the precise moment when all four wheels are positioned on the brake plates. After glancing to the left at the braking indicators, the inspector drives the vehicle to the last stop where the old safety lane sticker is scraped off and replaced with a new one. Each car is in the building for approximately 3 minutes. The engine is running continuously throughout the inspection. The doors at each end are always open for the lanes in use.

Approximately 320,000 inspections are performed each year. Figure 1 shows the average daily number of vehicles inspected by month at each inspection station for a 12-month period from April 1977 through March 1978. The number of cars inspected on the day of the survey at each station is also plotted. Note that 855 cars were inspected at the SW station on the day of the survey. This was an unusually high number for this time of year. Many people were off work for political voting purposes. The number of vehicles inspected can vary from 200 to 1000 per day for each station based on the data used in Figure 1.

A project to upgrade the ventilation system in both inspection stations was completed in the spring of 1977. The project included new, larger exhaust fans mounted on the roof, new ceiling duct work, and new ducts down the outside of the center pillars in the SW station.

Figure 2 is a sketch of the basic floor plan for the inspection stations. Both stations are similar as far as structure and ventilation methods. The overhead (OVHD) exhaust system draws air in at the base of brick pillars (terra cotta flues) and exhausts at roof level. Additional exhaust is provided by reversible, 10,000 CFM window fans. There are 6 at the SW station and 4 at the NE station. The center pillars have exhaust grills on two sides. Pedestal floor fans are also available for use as needed. A hot-wire anemometer was used to take three readings at each pillar exhaust grill (top, center, bottom). Their readings were averaged and then totaled to get the approximate total exhaust rate for the OVHD system. There is no make-up air system.

Offices and squad rooms are air conditioned using window air conditioning units.

#### B. AIR SAMPLING/ANALYTICAL METHODS

Personal air sampling and analysis for lead was conducted in accordance with the provisions of NIOSH method number P & CAM 173.<sup>1</sup> A 37 mm membrane filter (0.8  $\mu$ m pore size) in a cassette holder was attached to the collar of each worker. A personal sampling pump, operating at 1.5 lpm, was clipped to their belt and attached to the cassette via a piece of flexible tubing. Any lead in the air being drawn through the filter will be trapped on the filter surface. The filters are then digested in nitric acid for subsequent analysis using atomic absorption spectrophotometry.

NIOSH method number P & CAM 239<sup>1</sup> was used for sampling and analysis for airborne asbestos fibers. The sampling train is similar to the lead technique above except that an opened face filter was used and the sampling units were placed in the area of the station where the brake testing is accomplished. Any fibers trapped on the filter are sized and counted using a phase-contrast microscope at 400-450X magnification.

Airborne concentrations of hydrogen sulfide and sulfur dioxide were evaluated using detector tubes. A controlled amount of air is drawn through the tubes. A discoloration of the sorbent in the tube indicates the presence of the H<sub>2</sub>S or SO<sub>2</sub> and the length of the stain corresponds to the concentration.<sup>2</sup>

Personal sampling for carbon monoxide (CO) was conducted using a relatively new carbon monoxide dosimeter made by General Electric.\* The CO dosimeter is a self-contained unit that records the CO dosage to which personnel are exposed. It also provides warning lights and audible alarms that are activated when preset CO levels are exceeded. A yellow light comes on at an exposure level of 100 ppm and a red light comes on and a buzzer activates at 200 ppm. The ambient air is drawn into the dosimeter through the filter by the sample air pump. The sample is then discharged to the CO sensor cell where the CO is oxidized, producing an electrical signal proportional to the CO level. The level of CO is continuously integrated to provide a cumulative total of ppm-hours which can be read out later on the support console. This value, if divided by the number of hours sampled, will represent a time-weighted-average (TWA) exposure.

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

A CO-Ecolyzer was also used throughout the day at both inspection stations to evaluate peak levels of CO. This is a direct reading instrument accurate to within  $\pm 1$ ppm on the 0-100 ppm scale and  $\pm 6$  ppm on the 0-600 ppm scale if calibrated daily.<sup>2</sup> A 52 ppm carbon monoxide span gas was used to calibrate the ecolyzer before, during and after each day of sampling.

Eighteen inspectors were given pre-shift and post-shift carboxy hemoglobin (COHb) tests. The tests were administered in accordance with the procedures in reference 3 by analyzing the CO content of the expired breath using a CO-Ecolyzer. COHb levels were then estimated using the following equation.

$$\text{COHb}(\%) = 0.5 + \frac{\text{CO conc. in expired air (ppm)}}{5}$$

### C. TOXICOLOGY

One of the characteristic effects of Lead exposure is anemia. Lead interferes with the synthesis of heme. Other effects are loss of appetite, constipation, pallor, weakness, insomnia, headache and colic. In workers who have been repeatedly over-exposed to lead, there is a tendency towards the occurrence of weakness of extensor muscle groups. This weakness may progress to palsy, often observed as a characteristic "wrist drop" or "foot drop."<sup>4</sup> Ingestion and inhalation are the primary routes of entry into the body.

Prolonged exposures to airborne Asbestos fibers can result in a type of pneumoconiosis referred to as asbestosis. This is a fibrotic disease of the lungs which can impair the transfer of oxygen to the blood and result in respiratory insufficiency, or cardiac failure. Studies have also shown that exposure to asbestos fibers causes cancer in man. The occurrence of lung cancer is greater in those occupationally exposed to asbestos fibers.

The main health effect of exposure to Sulfur Dioxide is severe irritation, especially of the mucous membrane. Exposure to concentrations above 20 ppm cause choking and sneezing. Higher levels of exposure cause severe irritation to the nose, throat and eyes. Bronchitis, influenza, and asthma-like attacks have been attributed to sulfur dioxide exposure.

Hydrogen Sulfide is a primary irritant of the respiratory tract causing rhinitis, pharyngitis, bronchitis, and pneumonia. Hydrogen sulfide can penetrate deep into the lungs and cause hemorrhagic pulmonary edema. Irritant effects are due to the formation of alkali sulfide when the gas comes in contact with moist tissues. Hydrogen sulfide's strong odor, noticeable at low concentrations, is a poor warning sign as it may cause olfactory paralysis. Some persons are congenitally unable to smell hydrogen sulfide.

Carbon Monoxide is classified as a chemical asphyxiant gas whose toxic action is a direct result of the hypoxia (lack of oxygen) produced by a given exposure. CO rapidly transfers in the lungs from inhaled air to the blood where it is reversibly bound to hemoglobin in the red blood cells forming carboxyhemoglobin (COHb). This is the same mechanism whereby oxygen is taken from the inhaled air and delivered to tissue cells throughout the body. Hemoglobin has 200 times more affinity for CO than O<sub>2</sub> thereby resulting in a significant reduction in the oxygen-carrying capacity of the blood under exposure to even low concentrations of CO. Symptoms will vary according to the COHb saturation level (measured in %) and be the same as those encountered when exposed to an oxygen-deficient environment. These may include headache, nausea, vomiting, dizziness, drowsiness, and collapse.

#### D. Environmental Standards

The current NIOSH recommended exposure standards and the current legal OSHA standards for the substances evaluated during this survey are shown in Table 1.

#### IV. RESULTS

The results of the atmospheric lead sampling are shown in Table 2. All levels were below applicable standards at the SW station and non-detectable at the NE station.

There were no detectable levels of airborne asbestos at either station at the time of sampling. (Table 3)

No detectable levels of hydrogen sulfide or sulfur dioxide were found at either inspection station on the days of sampling. Detector tube readings were taken in the general area of the work stations. Positive readings were only obtained when the sample was taken close to the exhaust pipe of a vehicle.

Carbon monoxide approximate 8-hour time-weighted-average (TWA) levels are shown in Table 4 as are the results of the breath analysis testing. TWA levels of CO were below the OSHA standard at the NE station on the day of sampling but equal to or within 1 ppm of the 35 ppm, NIOSH standard for 4 of the 9 inspectors at the SW station. The 200 ppm NIOSH ceiling level was exceeded in both stations frequently throughout the day. Peak levels of 400-500 ppm for 30 seconds or less were obtained using the CO-Ecolyzer meter.

Post exposure COHb levels were less than the NIOSH recommended level of 5% for the nonsmokers at the NE station but greater than 5% in all five nonsmokers at the SW station. The maximum nonsmoker, post-shift % COHb at the SW station was 8.3. All cigarette smokers had COHb levels greater than 5% even at the beginning of the shift. The maximum cigarette smokers post-shift COHb level was 11.9%.

Ambient CO levels (outside of the building) ranged from 10-15 ppm as determined using the CO-Ecolyzer meter.

Ventilation data is compiled in Table 5. The design levels shown in the table were taken from the renovation project drawings. The actual levels were obtained using a hot-wire anemometer as explained in Section III A. It is estimated that the exhaust systems at the NE station were operating at approximately 98% of design levels while the SW station's systems were operating 14% above design levels. Ambient air currents at the center of the buildings ranged from 25 to 500 FPM. This range of readings was due to the changing direction and velocity of wind currents around and through the inspection stations.

#### V. DISCUSSION OF RESULTS

Time-weighted-average exposures during vehicle inspection tasks are primarily affected by the number of vehicles inspected each day and weather conditions. A maximum exposure condition would occur on a day when a high number of vehicles are inspected and the weather is hot and humid with stagnate air. The high number of vehicles would cause three lanes to be used the majority of the time. Under this condition, six to nine vehicles could frequently be in the building at one time as compared to two to six vehicles on a slower day when only two lanes would be used the majority of the time. There would also be more occasions when there were no vehicles in the building on slower days.

Stagnant air would result in higher ambient levels of emission products and not allow for the advantage of the dilution ventilation resulting from general air currents through the stations.

Peak exposure levels would be less affected by these factors since the high, short-term levels would tend to occur each time an inspector was momentarily very near the direct exhaust from the vehicle or directly upwind, very near the vehicle. Of course, the number of peak levels per day would vary directly with the number of vehicles inspected. The potential for exposure to airborne lead exists because an undetermined number of vehicles inspected still use leaded gasoline. This potential is confirmed by the fact that all nine personal samples taken for lead at the SW station were positive. The fact that no airborne lead was found at the NE station supports the logical assumption that the TWA

level of exposure depends on the number of cars inspected. The SW station inspected 300 more vehicles on the day surveyed than the NE station. Additionally, since the highest lead level found at the SW station (.017 mg/M<sup>3</sup>) is less than one-fifth of the most stringent, current standard (NIOSH, .10 mg/M<sup>3</sup>), and considering that a high number of vehicles were inspected (855), it is not likely that exposure to lead offers a significant health hazard under normal operating conditions.

There does not appear to be a health risk from exposure to asbestos. No detectable levels were found at either inspection station. The sampling devices were placed in the immediate vicinity of the location where the brakes are sharply applied. Inspectors are inside of the vehicle at this point. Over exposure to asbestos from brake lining is generally associated with repair procedures where the brake drums are blown out using compressed air or brake linings are ground using an abrasive wheel.

The fact that no detectable levels of hydrogen sulfide or sulfur dioxide were found at either inspection station indicates that current health standards for these substances are probably not routinely exceeded. However, due to the potential for exposure from vehicles using catalytic converters and the complaints from several employees of burning eyes and a sulfur taste in their mouth on certain days (hot, humid, stagnant air conditions), it is recommended that a re-evaluation during a time of maximum risk exposure conditions be accomplished.

The dosimeters used for TWA CO exposures were not well suited for the type of exposure encountered. The electro-chemical reaction used to assimilate CO exposure data was too slow to record the entire high, short-term peak levels. Therefore, the TWA exposure data for CO (Table 4) are probably lower than actual exposures. The extent of the error is not known.

Carboxyhemoglobin saturation levels estimated from measurement of CO in the expired breath have been shown to be a valuable tool in estimating recent CO exposure levels.<sup>3</sup> Nonsmokers tend to approach a 5% COHb level when engaged in sedentary activity while continuously exposed to 35 ppm for an 8-hour period.<sup>5</sup> Cigarette smokers who smoke 1 and 2 packs per day have COHb saturation levels of 5-6% and 7-9% respectively.<sup>6</sup> The differences in COHb levels between the smokers and nonsmokers is illustrated in Table 6. Note that the average increase in COHb level ranged from 1.6 to 2.4%. This indicated that, on the average, the COHb level was increased approximately 2% due to CO exposure while performing vehicle inspection tasks.

In general, both the TWA levels for CO and COHb levels were higher at the SW station than at the NE station. This can be attributed to the fact that 325 more cars were inspected at the SW station.

The fact that the TWA CO exposure level is subject to vary tremendously from day to day makes the determination of health effects difficult. Additionally, the long-term health effects resulting from the daily, short-term peak levels of CO exposure are undetermined. Caution should be used in placing personnel with underlying heart disease in such environment since the abnormal heart may not be able to meet the higher demand placed on it under such conditions.

## VI. CONCLUSIONS

Time-weighted-average exposures to vehicle emissions during routine inspection tasks can change significantly from day to day depending on the number of vehicles inspected and weather conditions. Of concern is the potential for high exposures to carbon monoxide. Frequent very short-term exposures to levels of 400-500 ppm were observed at both the SW and NE inspection stations. Due to the the fluctuating exposure levels, the long-term health effects are unclear.

The newly installed exhaust ventilation system may not be effective for controlling emission products under maximum exposure conditions and, in its present configuration, does not effectively control short-term peak CO levels.

No detectable levels of asbestos, hydrogen sulfide or sulfur dioxide were measured on the days of the survey. Airborne lead levels of less than one-tenth of the current OSHA standard (0.20 mg/M<sup>3</sup>) were found at the SW station. Further evaluation is needed to determine the exposure levels during a condition of maximum risk when a high number of vehicles are inspected (800-1000) and the weather conditions are hot and humid with stagnant air.

CO monitoring systems should be evaluated for application at each inspection station. However, unless the current exhaust system is altered as recommended, the alarm would be activated frequently if set at the current NIOSH ceiling level of 200 ppm. Table 6 lists several manufacturers that can be contacted for information on CO monitoring system. There may be other manufacturers that also make these units.

Several floor fans were available but not used during the time of this survey. It is recommended that they be utilized as needed to assist in directing exhaust fumes away from inspectors.

## VII. RECOMMENDATIONS

Over 95% of the total time that a vehicle is in the inspection station is spent at the first and last stop. More effective control of emissions at these two locations will greatly reduce both peak level and average exposure levels within the facility. Possibly, one of the exhaust grills on either side of each lane at both ends of the building could be altered to accept a flexible, counter-balanced tubing that would efficiently collect exhaust emissions. This type of a system would be similar to that used in welding environments and could be used with very minimal increase in inspection time per vehicle. In effect, the current general ventilation system would be partly converted to a more effective local ventilation system.

Until a more efficient ventilation system is adopted, pre-employment physicals should be given which stress evaluation of the cardiovascular system. Caution should be used in using personnel with underlying heart disease as inspectors considering the potential for high levels of carbon monoxide. It is also recommended that inspectors be given this same type of physical yearly.

Unless higher lead exposure levels than found during this survey can be documented, it is not recommended that blood samples be routinely obtained for lead analysis. Although there is a potential for lead exposure, the risk appears to be minimal based on the results of this study.

Continue the current practice of rotating personnel and allowing at least two breaks in the morning and afternoon.

Insure that squad rooms are air conditioned.

Continue current policy of using only as many lanes as necessary which allows for maximum number of breaks and decreases the number of vehicles in the building at one time.

Inspection lane areas should be vacuumed daily to prevent the possibility of settled lead or asbestos particles from becoming airborne again the next day.

Inspectors should wear gloves and wash their hands thoroughly before eating to prevent ingestion of lead particles.

Inspectors should be educated about the additional problems regarding smoking cigarettes and increased carboxyhemoglobin levels.

Consider methods of spreading out the number of vehicles inspected more evenly throughout the year, i.e.: have people who live in a certain area or have a specific first letter of their last name report for inspection during a specific month.

#### VIII. REFERENCES

1. Analytical Method for Trace Metals, P & CAM #173, NIOSH Manual of Analytical Methods, Volume 1, April, 1977.
2. Carl D. Parker and R. B. Strong, "Evaluation of Portable, Direct Reading Carbon Monoxide Meters". HEW Publication No. (NIOSH) 75-106.
3. Alan Ringold, M.D. et. al., "Estimating Recent Carbon Monoxide Exposure: A Rapid Method". Arch. Env. Hlth. 5:308-318, 1962.
4. Moyers, M. R.: Occupational Health--Hazards of the Work Environment. Baltimore, Williams and Wilkins, Co., 1929, p. 444.
5. 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.
6. Stewart, R. D. et al. : Carboxyhemoglobin Levels in American Blood Donors. JAMA 229:1187-95, 1974.

IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

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TABLE 1  
ENVIRONMENTAL STANDARDS

SUBSTANCE	NIOSH	OSHA
Lead	Less than 0.1 mg/m <sup>3</sup> *	.20 mg/m <sup>3</sup> * (proposed, .05 mg/M <sup>3</sup> )
Asbestos	0.1 fibers/cc (fibers >5 microns in length):*0.5 fibers/cc as a 15-minute ceiling	2 fibers/cc with 10 fibers/cc ceiling. Fiber length >.5 microns.
H <sub>2</sub> S	10 ppm ceiling (10 minute)	20 ppm acceptable ceiling, 50 ppm maximum ceiling
SO <sub>2</sub>	0.5 ppm*	5 ppm*
CO	35 ppm.* No worker should be exposed to ceiling concentrations of 200 ppm or exceed COHb of 5%	50 ppm*

\*Represents a time-weighted-average (TWA) exposure for a 8-hour workday.

TABLE 2  
WASHINGTON, D.C. MOTOR  
VEHICLE INSPECTION STATIONS

## Lead Analysis

<u>*Working Position</u>	mg/m <sup>3</sup>
NE Inspection Station	
1. Line	<.007
2. Line	<.007
3. Sticker	0.016
4. Line	<.007
5. Line	<.008
6. Line	<.008
7. Line	<.007
8. Sticker	<.007
9. Sticker	<.008
SW Inspection Station	
10. Line	.017
11. Sticker	.016
12. Line	.013
13. Line	.008
14. Line	.009
15. Sticker	.009
16. Sticker	.011
17. Line	.012
18. Line	.008

\*Personal breathing zone samples. Sampling ranged from 7.5 to 8.5 hours.

TABLE 3  
WASHINGTON, D.C. MOTOR  
VEHICLE INSPECTION STATIONS

## Asbestos Analysis

<u>*Area Sample</u>	<u>Fibers/cc</u>
NE Inspection Station	
Lane 1	<.007**
Lane 2	<.007
Lane 3	<.007
SW Inspection Station	
Lane 2	<.007
Lane 3	<.007
Lane 4	<.007

\*Sampling pump strapped to breaking indicator pillar at about 4.5 feet above the floor.

\*\*A "<" value indicates that there was no detectable level of asbestos fibers.

TABLE 4  
WASHINGTON, D.C. MOTOR  
VEHICLE INSPECTION STATIONS  
CARBON MONOXIDE

Working Position	TWA, ppm <sup>1</sup>	Breath Analysis				
		Measured CO <sup>2</sup> , ppm <sup>3</sup>		Estimated COHb (%) <sup>2</sup>		
		Pre-shift	Post Shift	Pre-shift	Post Shift	Δ%COHb
NE Inspection Station						
**1	22.8	440**	170**	88**	34.5**	----
*2	22.0	16	32	3.7	6.9	+3.2
*3	10.5	49	49	10.3	10.3	0
*4	13.6	33	50	7.1	10.5	+3.4
5	14.3	12	16	2.9	3.7	+0.8
6	14.7	10	13	2.5	3.1	+0.6
7	11.3	13	17	3.1	3.9	+0.8
8	9.9	8	15	2.1	3.5	+1.4
*9	23.1	31	49	6.7	10.3	+3.6
SW Inspection Station						
*10	34.4	52	57	10.9	11.9	+1.0
11	32.1	13	26	3.1	5.7	+4.6
12	28.2	16	38	3.7	8.1	+4.4
***13	34.4	47	39	9.9	8.3	-1.6
*14	35.8	24	40	5.3	8.5	+3.2
*15	34.8	22	25	4.9	5.5	+0.6
16	31.5	14	31	3.3	6.7	+3.4
*17	25.0	20	28	4.5	6.1	+1.6
18	27.3	13	24	3.0	5.3	+2.3

1. Sampling times ranged from 7.5 to 8.5 hours 2. CO in expired breath measured with CO-Ecolyzer. Carboxyhemoglobin(COHb)level in blood estimated using equation  $\%COHb = .5 + \frac{CO(ppm)}{5}$  as described in reference<sup>3</sup> \*Smoker \*\*smoker and alcohol prior to workshift, breath sample invalid \*\*\* Rode in car pool of smokers - Only individual that had a post shift COHb less than pre-shift COHb.

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TABLE 5  
 WASHINGTON, D.C. MOTOR VEHICLE  
 INSPECTION STATION  
 EXHAUST VENTILATION DATA

	NE Station		SW Station	
	<u>Design</u>	<u>Actual</u>	<u>Design</u>	<u>Actual</u>
OVHD Ventilation System (CFM)	64,500	62,350	60,000	76,650
Window Exhaust Fans (CFM)	<u>40,000</u>	<u>40,000</u>	<u>60,000</u>	<u>60,000</u>
Total Exhaust (CFM)	104,500	102,350	120,000	136,650
Approximate Vol. of Inspection Lanes (FT <sup>3</sup> )		174,000		315,000
Approximate Changes Per Hour (Actual)				
OVHD System only		21.5		14.6
Window Exhaust only		<u>13.8</u>		<u>11.4</u>
Total		<u>35.3</u>		<u>26.0</u>
General Air Velocities chest height, center of building (FPM)		25-400		25-500

TABLE 6  
SMOKER - NON-SMOKER  
CARBOXYHEMOGLOBIN (COHb)  
NE and SW Inspection Stations

	<u>Number People</u>	<u>Average Pre-shift</u>	<u>Average Post Shift</u>	<u>Average <math>\Delta</math> %</u>
Cigarette smokers	5	8.1	10.3	+2.2
Pipe smokers	3	4.4	6.2	+1.6
Non-smokers	9 <sup>1</sup> (8) <sup>2</sup>	3.7 <sup>1</sup> (3.0)	5.4 (5.2)	+1.7 (2.4)

Note:

1. The nine pre-shift COHb levels are: 2.9, 2.5, 3.1, 2.1, 3.1, 3.7, 9.9, 3.3, and 3.0. The 3.7 average pre-shift COHb level is significantly influenced by the 9.9 level of the individual who was a non-smoker but rode to work in a car pool with two other people who were smokers.
2. Numbers in parenthesis represent average COHb levels for the non-smokers excluding the one individual whose pre-shift COHb levels was apparently influenced by the car pool exposure.

TABLE 7  
MANUFACTURERS OF CO\*  
MONITORING SYSTEMS

E. D. Bullard Company  
2680 Bridgeway  
Sausalite, California 94965

Dortmund W. Germany  
Distributed by: Daco Products, Inc.  
12 South Mountain Avenue  
Montclair, New Jersey 07042

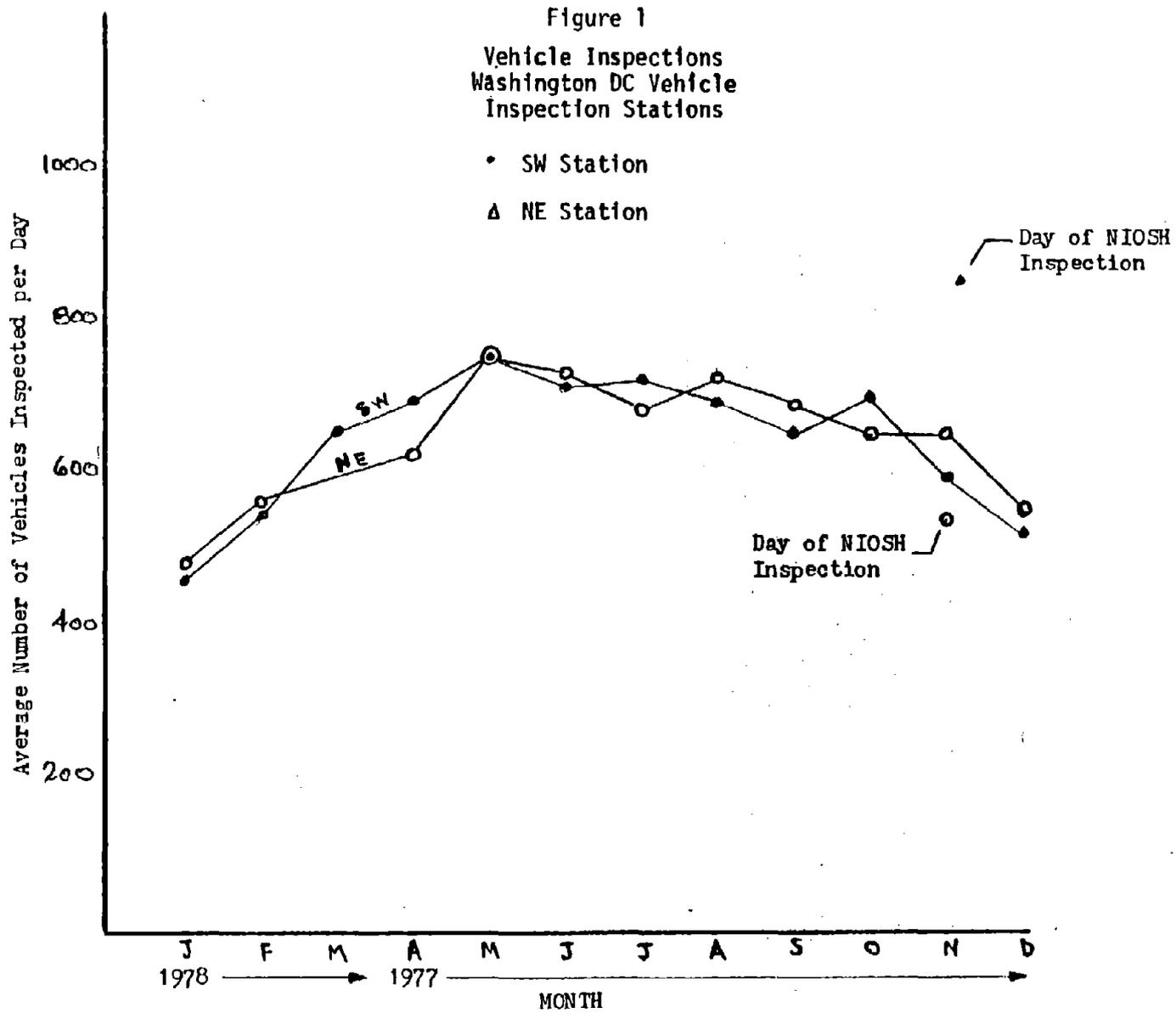
Energetic Sciences, Inc.  
4461 Bronx Boulevard  
New York, New York 10470

Environmental Metrology Corporation  
2308 South Industrial Highway  
Ann Arbor, Michigan 48104

Mine Safety Appliances Company  
201 North Braddock Avenue  
Pittsburgh, Pennsylvania 15208

Wilkes Scientific Corporation  
Box 449  
South Norwalk, Connecticut 06856

\*Mention of these manufacturers does not constitute NIOSH endorsement but simply provides sources for information on CO monitoring systems. There may be other companies not mentioned who manufacturer such equipment.



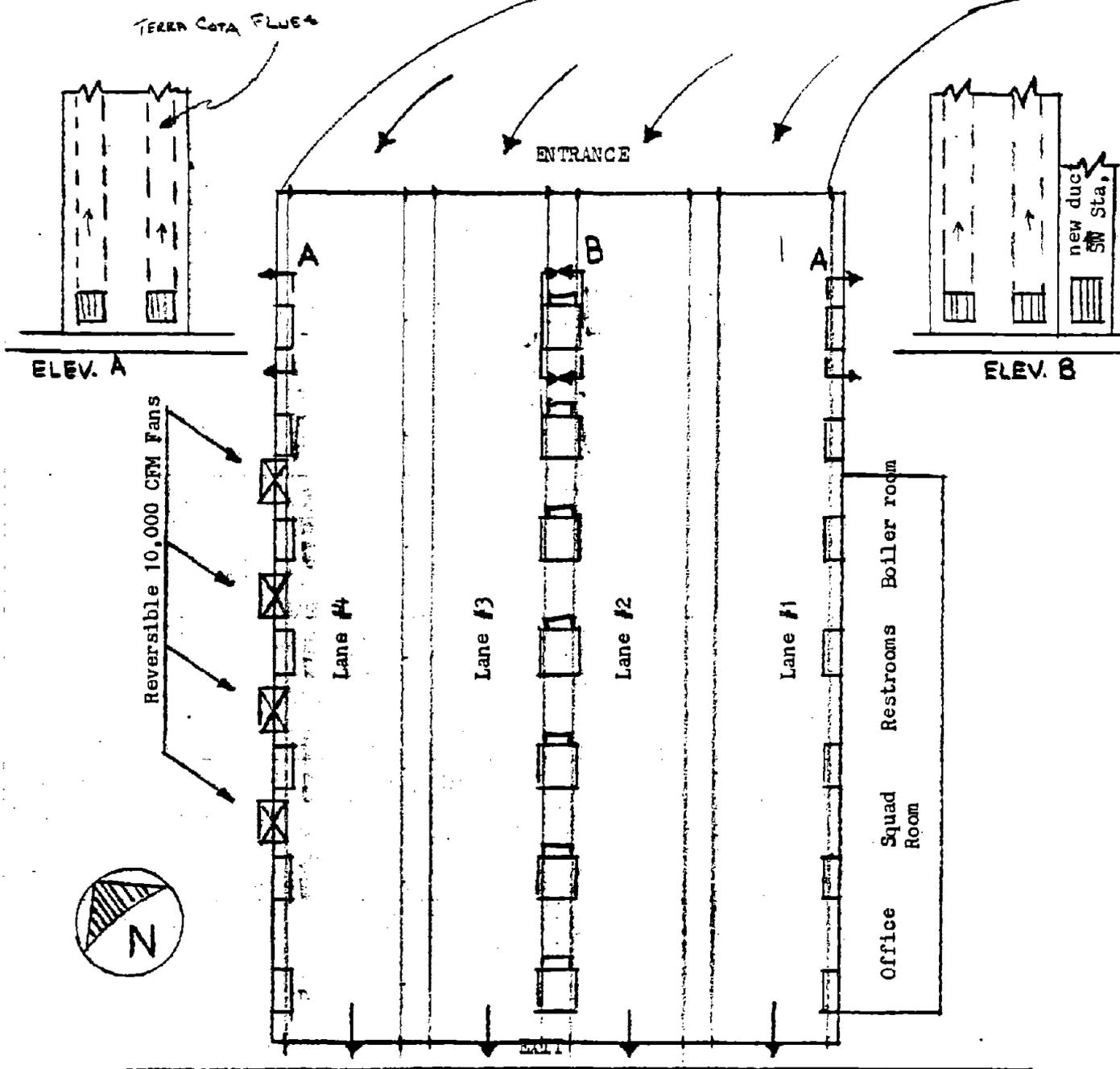


Figure 2  
Vehicle Inspection Stations  
Washington, DC