HEALTH HAZARD EVALUATION REPORT 72-32-42

HAZARD EVALUATION SERVICES BRANCH

DIVISION OF TECHNICAL SERVICES

ESTABLISHMENT	:	Union Pacific Railroad Pocatello, Idaho
REPORT PREPARED BY	:	Arvin G. Apol, Project Officer Regional Industrial Hygienist Region X, Seattle, Washington
FIELD EVALUATION	:	Arvin G. Apol, Industrial Hygienist William L. Wagner, Industrial Hygienist Bert T. Wisner, Industrial Hygienist
LABORATORY ANALYSES	:	Russel Hendricks, Ph.D. Western Area Occupational Health Laboratory
ORIGINATING OFFICE	:	Jerome P. Flesch Chief, Hazard Evaluation Services Branch Cincinnati, Ohio

MAY 1973

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
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UNION PACIFIC RAILROAD
POCATELLO, IDAHO
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I SUMMARY DETERMINATION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by 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 National Institute for Occupational Safety and Health (NIOSH) received such a request from an authorized representative of employees regarding exposure to diesel engine exhaust at the Union Pacific Railroad Company, Run and Service Building, Pocatello, Idaho.

The substances used or found in the workplace with potentially toxic properties are listed below with their respective exposure standards as promulgated by the U.S. Department of Labor (Federal Register, Volume 37, 1910.93, October 18, 1972).

SUBSTANCE	STANDARD CONCENTRATION *	
Acrolein	0.1 ppm**	0.25 mg/M^3***
Carbon Monoxide	50	55
Formaldehyde	3	
	5****	
	10***** (maximum duration of 30 mins)	
Nitrogen Dioxide	5	9
Total oxidesof nitrogen as nitric oxide	25	30
Sulfur Dioxide	5	13
Total Particulates	-	15

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* Eight hour time-weighted average
** Parts of vapor or gas per million parts of contaminated air by volume at 25° C and 760 mm Hg pressure
*** mg/M^3 - milligrams of substance per cubic meter of air
**** Acceptable ceiling concentration
***** Acceptable maximum peak above the acceptable ceiling concentration for an eight hour shift

Shortly after this Health Hazard Evaluation, thirty-six new recently installed ceiling fans were put in operation. This makes a total of forty-six ceiling fans in the building. When all the fans are in operation, it is anticipated that the diesel exhaust concentration in the air will be lowered and therefore symptoms such as eye irritation probably should not occur.

Copies of this Summary Determination as well as the Full Report of the evaluation are available upon request from the Hazard Evaluation Services Branch, NIOSH, U.S. Post Office Building, Room 508, 5th and Walnut Streets, Cincinnati, Ohio 45202. Copies of both have been sent to:

a) Union Pacific Railroad Company
b) Authorized Representative of Employees
c) U.S. Department of Labor - Region X

For purposes of informing the approximately 125 "affected employees," the employer will promptly "post" the Summary Determination in a prominent place(s) near where affected employees work for a period of 30 calendar days.

II INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education and Welfare, following a written request by 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 concentration as used or found.

The National Institute for Occupational Safety and Health (NIOSH) has received such a request from an authorized representative of employees of the Union Pacific Railroad at Pocatello, Idaho.

The area involved in the request is the Run and Service shop, located at Pocatello, Idaho.

III HAZARD INFORMATION

A. Standards

The Occupational Health Standards as promulgated by the U.S. Department of Labor (Federal Register, volume 37, 1910.93 Tables G-1, 2 and 3 October 18, 1972) applicable to substance of this evaluation are as follows:

SUBSTANCE	STANDARD CONCENTRATION *	
Acrolein	0.1 ppm**	0.25 mg/M^3***
Carbon Monoxide	50	55
Formaldehyde	3	
	5****	
	10***** (maximum duration of 30 mins)	
Nitrogen Dioxide	5	9
Total oxides of nitrogen as nitric oxide	25	30
Sulfur Dioxide	5	13
Total Particulates	—	15

The substances listed are air contaminants present in diesel exhaust gases.

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* Eight hour time-weighted average

** Parts of vapor or gas per million parts of contaminated air by volume at 25° C and 760 mm Hg pressure

*** mg/M^3 - milligrams of substance per cubic meter of air

**** Acceptable ceiling concentration

***** Acceptable maximum peak above the acceptable ceiling concentration for an eight hour shift

B. TOXIC EFFECTS

Acrolein

"Acrolein has been reported to cause eye, nose, and throat irritation. The mean response of seven human subjects exposed to one ppm acrolein ranged from slight nasal irritation in one minute to moderate nasal irritation and practically intolerable eye irritation with lacrimation in five minutes. Five subjects experienced essentially the same effects at approximately 5 ppm in one minute. Elevated concentrations have been reported to cause edema of the lung.[2] Serious cases of intoxication are rare because humans usually will not tolerate the irritation effects for an appreciable period of time."[3]

Carbon Monoxide

Toxicity - The toxicity of carbon monoxide (CO) is related to its affinity for the hemoglobin molecule of blood. CO will combine with hemoglobin, which normally carries oxygen to the body tissues, to form a compound called carboxyhemoglobin (COHb). In the normal situation, the blood contains only oxyhemoglobin. The amount of COHb in the blood is proportional to CO exposure levels. The first noticeable effects occur when COHb saturation reached 10 to 20 percent and acute effects result from oxygen deprivation to vital organs (i.e., asphyxia).

The most common source of CO in the ambient atmosphere is generated by the emissions from the gasoline-powered, internal combustion engine. However, CO will be produced during the incomplete burning of any carbonaceous matter. Thus, cigarette smoking individuals may run levels of COHb from 2 to 10 percent without any other source of exposure. There is a normal background level of COHb which is approximately 1 percent. This is due to atmospheric contaminants and it is found in the blood of non-smokers.

The present TLV of 50 ppm for an eight hour time-weighted exposure was set by the American Conference of Governmental Hygienists on the basis that this level of CO will result in COHb concentrations between 8 and 10 percent (which should not produce worker discomfort). This standard does not take the long-term effects into account, nor does it address the fact that individuals who smoke will have higher levels of COHb and any workers with pre-existing arteriosclerotic cardiovacular disease (ASCVD) may be placed at serious risk. For these reasons, the recent "Criteria Document" on carbon monoxide that has been formulated by the National Institute for Occupational Safety and Health, recommends lowering the TLV to 35 ppm. Yet, they still warn that this level may not protect employees with known cardiovascular disease.[3]*

*References are listed in section VII, titled References.

Formaldehyde

"The major effect of exposure to formaldehyde in air is local irritation of the eyes, nose and throat. Some persons, if not acclimatized, will experience unpleasant eye, nose and throat irritation at concentrations below 5 ppm. Exposure to 10 - 20 ppm produces almost immediate eye irritation and a sharp burning sensation of the nose and throat may be associated with sneezing, difficulty in taking a deep breath and coughing. Recovery is prompt from these transient effects."(4)

Nitrogen Dioxide

"Exposures of relatively short duration to concentrations above 5 ppm produce cough and irritation of the respiratory tract. Continued exposure to concentrations much above 5 ppm may produce a slowly progressive and often fatal pulmonary edema and hemorage. High concentrations irritate mucous membranes and wet skin surfaces."(6)

Oxides of Nitrogen

Nitrous fumes consist of a mixture of NO, NO_2, N_2O_4, and N_2O_3. They dissolve in water to form nitric acid and nitrous acid. When these acids contact the mucous membranes of the respiratory tract in sufficient concentration they may cause damage to the alveoli, the lung capillaries and the bronchial and tracheal mucosa. Clinically nitrous fume poisoning is characterized by an initial stage of irritation followed, after a period of latency by a second stage with pulmonary edema. Also some of these gases probably react with alkaline substances in the lung forming nitrites which enter the circulatory system which may lead to the formation of methemoglobin which in turn decreases the transport of oxygen to tissues.(5)

Sulfur Dioxide

"Sulfur dioxide gas is an irritant gas: 6 to 12 ppm causes immediate irritation to nose and throat. Three-tenths to 1 ppm can be detected by the average individual, probably by taste rather than by odor and 3 ppm has an easily noticeable odor. About 20 ppm is the least amount irritating to the eyes." Altho sulfur dioxide dissolves readily and its inhalation affects chiefly the upper respiratory tract and bronchi, it may cause edema of the lungs or glottis and can produce respiratory paralysis."(7)

Nuisance Particulates

Nuisance dusts do not produce significant organic disease when exposures are kept under reasonable control. However, there is no dust that does not produce some cellular response in the lung when inhaled in sufficient amount.(8)

IV HEALTH HAZARD EVALUATION

A. Observation Survey

An initial hazard evaluation survey of the Union Pacific Railroad Company, Pocatello, Idaho was made on June 22, 1972 by NIOSH representative Arvin G. Apol

The function of the National Institute for Occupational Safety and Health and its relation to Section(a)(6) of the Occupational Safety and Health Act of 1970 and the purpose of the visit was explained to , Master Mechanic and to Chief Mechanical Officer for the Union Pacific Railroad, Omaha, Nebraska via telephone, followed by a letter dated June 27, 1972. The NSN Part I questionnaire was completed with the assistance of

. Shop Superintendent, met us at the diesel run and repair building. The diesel run and repair building and the diesel service building were toured and the operation explained.

Plant Process - conditions of use:

Engines are brought in the service building for servicing. The servicing consists of fueling, greasing and filling the sand boxes. The engines are often left running as was the case on the day of the visit. Six train engines and four switch engines were in the building. All the end doors and side windows were open and ten ceiling exhaust fans were on.

There are approximately 125 employees, who work in these two buildings. They work three shifts a day, seven days a week. The biggest work load occurs on Thursday, Friday and Saturday.

Private interviews were conducted with three employees. The general comments were that their eyes sometimes burn, they experience headaches and the odor is offending. The eyes of one employee interviewed were watering and red.

The run and service building was opened in March of 1972. The work was formerly done out of doors. explained that if their budget is approved, a heating and ventilation system will be installed to reduce the diesel exhaust in the building.

As a result of this initial visit it was determined that environmental measurements for diesel exhaust components consisting of carbon monoxide, oxides of nitrogen and aldehydes were needed in order to complete the required determination of exposure levels.

B. Environmental Evaluation

Environmental sampling was conducted on November 9-10, 1972 (Thursday and Friday) by NIOSH Representatives Arvin Apol, William Wagner and Bert Wisner using methods and procedures detailed below.

1. Sampling methods and procedures

a. Acrolein and formaldeyhyde - These samples were collected in 1% sodium bisulfite, using fritted bubblers and MSA model G pumps operated at 0.8 to 1.3 liters a minute. The sample time ranged from 161 minutes to 365 minutes. The acrolein samples were analyzed by a wet chemical method using mercuric chloride - hexylresorcinol reagent, and the formaldehyde samples were analyzed using the chromatropic acid method. The collected sample was used for both analyses.

b. Carbon monoxide - All carbon monoxide samples were collected using MSA and Drager detector tube pumps and direct reading detector tubes. The sample times ranged from 1 to 5 minutes in length.

c. Nitrogen dioxide and oxides of nitrogen - These samples were collected in Saltzman reagent using fritted bubblers and MSA model G pumps operated at 0.7 to 0.95 liters per minute. The sampling times ranged from 15 to 60 minutes. The color developed in the sampling reagent was read on a spectrophotometer.

d. Sulfur dioxide - The sulfur dioxide samples were collected in 0.7% hydrogen peroxide using fritted bubblers and MSA model G pumps operated at 0.5 to 0.65 liters per minute for 420 minutes and analyzed using the barium titration method.

e. Total Particulates - The total particulate samples were collected on 37 mm, millipore type AA 0.8u cellulose filters and MSA model G pumps operated at 2 liters per minute. The sampling times ranged from 172 minutes to 424 minutes. The filters were conditioned and weighed before and after in a Cahn Electrobalance model G-2.

2. Sample location and background information

The run and service building is 552ft long, 60ft wide and approximately 35-40ft high (figure 1). There are two sets of tracks running through the building. The contaminants are released from the exhaust pipes located on the top of the engines and are dispersed through the building before reaching the breathing zone, therefore, area samples were considered representative of the workers exposure. Nine sampling points, evenly spaced, five feet above the floor were selected for sampling.

During the sampling period various units were moved in, serviced, and moved out. There were units in the building almost the entire sampling period. The union representative stated that the work load was normal. All sample times were selected on a random basis, without regard to the kind and number of units in the building.

3. Results

The sample results are listed in the tables in section III.

Acrolein & formaldehyde	Table I
Carbon monoxide	Table II
Nitrogen Dioxide & total oxides of nitrogen	Table III
Sulfur dioxide	Table IV
Total particulates	Table V

All the contaminants sampled were well below the existing standards listed in Section III of this report. The acrolein concentrations ranged from less than 0.015 ppm to less than 0.04 ppm., (standard-0.1 ppm) the formaldehyde concentrations from 0.015 ppm to 0.07 ppm (standard 3 ppm), the nitrogen dioxide concentrations from 0.01 ppm to 0.06 ppm (standard 5 ppm), the total oxides of nitrogen (reported as nitric oxide) concentrations from 0.3 ppm to 0.26 ppm (standard 25 ppm) and the sulfur dioxide concentrations were all less than 0.01 ppm (standard 5 ppm). The total particulates (reported as nuisance dusts) ranged from 0.09 mg/M^3 to 0.26 mg/M^3 (standard 15 mg/M^3). The carbon monoxide concentrations ranged from 1 ppm to 15 ppm (standard 50 ppm). When two or more hazardous substances are present, their combined effect rather than that of either individually should be given primary consideration. In the absence of information to the contrary, the effects of the different hazards should be considered as additive. Using this criteria, the standard for the mixture was not exceeded.

For one-30 minute period (out of 20 hours of sampling time) while one set of engines were in the shop, NIOSH investigators noted eye irritation, manifested by slight burning. However, short term samples were not collected during this period, as there was no prior indication that this condition would occur. This indicates that occasionally there are gases and vapors present in sufficient concentrations to cause some discomfort to the employees. The new controls being installed probably will prevent such occurrences.

4. Controls

The following changes in the ventilation were or are being made.

a. Thirty-six additional ceiling fans are being added (exhaust capacities unknown). They have been installed and were being wired during our visit. This plus the original ten fans makes 46 ceiling fans. With only ten fans operating, the chance of an engine exhaust being under a fan was very low. When the new fans are operating, the engine exhaust should almost always be under a fan.

b. Provisions for make-up air were not provided when the building was completed a year ago. The company has installed 46 open louvered grilles evenly spaced around the building. Each grille is about 4ft by 10ft in size and located about 14ft above the floor.

Reentry of the exhausted air through the louvered grilles could occur under unique weather conditions. The ceiling fans exhaust the contaminated air straight upward so the possibility of reentry is low.

C. Medical Evaluation

A medical survey was not performed in connection with the hazard request. A complete medical evaluation was made on April 19-20, 1972 by the Western Area Occupational Health Laboratory, NIOSH, Salt Lake City, Utah.(9) "The study included a chest x-ray, a Forced Expiratory Spirogram, and a questionnaire oriented to pulmonary symptoms and a smoking history. Questions were also asked about symptoms relevant to carbon monoxide exposure. One-hundred and seventeen men were tested. Ninety of these men worked in the Run and Service Building and the remainder in other areas of the facilities."

"Questionnaire - Thirty-one out of 114 males were classified as having symptoms of bronchitis. A careful review of the recent literature showed a prevalence of chronic bronchitis among industrial and non-industrial population between 5-40%. Because of the extensive variability in age, sex, smoking history, geographic location, and occupation, comparison of our data with other studies is difficult if not impossible."

"Spirometry - Using the Los Angeles Breathmobile study of 10,000 industrial workers, a statistical comparison of abnormal spirometry frequency was performed. Twelve abnormal spirograms were identified as compared to the expected of 7.2 for this particular population. Applying the Chi Square test, this difference was not found to be statistically significant; that is the spirometric results of this study fall within the range of that expected."

"Chest X-Ray - No pneumoconiotic lesions were identified on chest roentgenogram; i.e., past exposure to fibrogenic dusts has apparently not been significant."

"Using the most objective means of medical analysis available (Spirometry), excessive chronic respiratory disease probably does not exist among those surveyed in this plant. In addition, there is no reason to believe that pneumoconiosis is a significant problem at this time."

D. Conclusions

Exposure to individual substances evaluated (acrolein, carbon monoxide, formaldehyde, oxides of nitrogen, sulfur dioxide and total particulates) were all below the OSHA promulgated standards. When two or more substances have similar health effects the hazards should be considered additive. Using this criteria, the standard for the mixture was not exceeded.

Eye irritation may occur for short periods of time depending on the condition (properly tuned, etc.) of the units in the building at that time. This condition is not predictable and does not appear frequently. It is anticipated that the new fans and air supply openings will prevent occurences such as this.

Excessive chronic respiratory disease does not appear to be present in the workers at this facility. In addition, there is no reason to believe that pneumoconiosis is a significant problem at this time.

V Recommendation

The engines should be shut off whenever possible during the servicing period. During our visit several units were shut off, so it appears that this is feasible.

VI References

1. Criteria for a recommended standard...Occupational Exposure to Carbon Monoxide. U.S. Department of Health, Education, and Welfare, National Institute for Occupational Safety and Health.

2. Acrolein-Hygienic Guide Series of the "American Industrial Hygiene Association".

3. Patty, F. A. (editor) "Industrial Hygiene and Toxicology", Vol II, 2nd ed., p 1979. John Wiley and Sons, Inc, New York 1963.

4. Formaldehyde - Hygienic Guide Series of the American Industrial Hygiene Association.

5. Moeschlin, S.: "Poisoning Diagnosis and Treatment", Grune and Stratton, New York and London, 1965.

6. Nitrogen Dioxide-Hygienic Guide Series of the American Industrial Hygiene Association.

7. Patty, F. A. (editor) "Industrial Hygiene and Toxicology," Vol II, 2nd ed., p 894, John Wiley and Sons, Inc., New York 1963.

8. TLV's Threshold Limit Values for Chemical Substances and Physical Agents in the workroom environment with intended changes for 1972. American Conference of Governmental Industrial Hygienist.

9. "Union Pacific Roundhouse Medical Survey," Pocatello, Idaho; April 19-20, 1972. Alan Palmer, et al., Western Area Occupational Health Laboratory, NIOSH, Salt Lake City, Utah.

VII FIGURE AND TABLES

FIGURE 1

RUN & SERVICE BUILDING UNION PACIFIC RAILROAD

POCATELLO, IDAHO

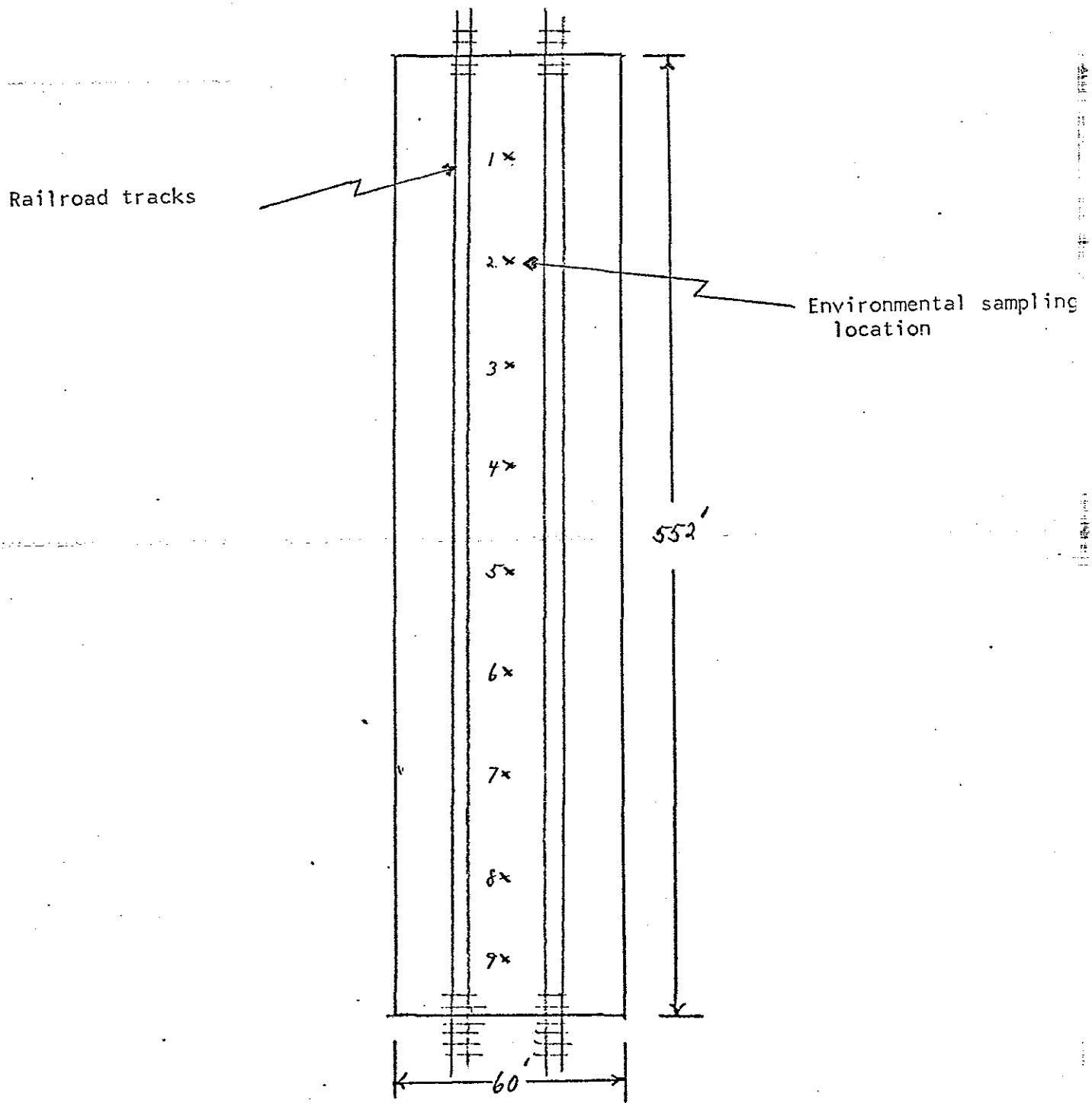

TABLE I

Acrolein and Formaldehyde

(Standard: Acrolein = 0.1, ppm Formaldehyde = 3 ppm)*

Date	Shift #	Sampling Station	Sample Time (min)	Sample #	Acrolein ppm	Formaldehyde ppm
11/9/72	1	1	365	A-1	<0.015	0.015
11/9/72	1	3	365	A-2	<0.015	0.015
11/9/72	1	5	365	A-3	<0.016	0.015
11/9/72	1	7	365	A-4	<0.015	0.015
11/9/72	1	9	365	A-5	<0.015	0.02
11/9/72	2	1	326	A-6	<0.017	0.02
11/9/72	2	3	326	A-7	<0.015	0.02
11/9/72	2	5	326	A-8	< .014	0.2
11/9/72	2	7	327	A-9	<0.018	0.02
11/9/72	2	9	328	A-10	<0.016	0.05
11/10/72	1	1	161	A-11	<0.04	0.07
11/10/72	1	3	162	A-12	<0.037	0.06
11/10/72	1	5	163	A-13	<0.034	0.045
11/10/72	1	7	164	A-14	<0.04	0.07
11/10/72	1	9	164	A-15	<0.031	0.05

*Standards as promulgated by U.S. Department of Labor (Federal Register Part II, 1910.93)

TABLE 11

CARBON MONOXIDE (CO)

(CO Standard = 50 ppm)*

DATE	SAMPLING LOCATION	SAMPLE #	CO ppm
11/09/72	2	1	<1
"	4	2	<1
"	6	3	<1
"	7 & 8	4	5
"	7 & 8	5	10
"	2 & 3	6	15
"	6 & 7	7	<1
11/10/72	6 & 7	8	10
"	5 & 6	9	12
"	5 & 6	10	8

*Standards as promulgated by U.S. Department of Labor (Federal Register Part 11, 1919.93)

TABLE III

NITROGEN DIOXIDE & TOTAL OXIDES OF NITROGEN (REPORTED AS NITRIC OXIDE)
(Standard-Nitrogen Dioxide = 5 ppm, Nitric Oxide 25 ppm)*

DATE	SAMPLING STATION	NO_2 SAMPLE #	NO_2 TIME (min)	TOTAL OXIDES OF NITROGEN SAMPLE #	TOTAL OXIDES OF NITROGEN TIME (min)	NO_2 ppm	TOTAL OXIDES OF NITROGEN ppm
11/09/72	2	1	54	8	36	0.01	0.03
"	4	2	54	7	36	0.01	0.04
"	6	3	47	6	29	0.03	0.03
"	8	4	57	5	39	0.02	0.05
"	2	9	37	13	24	0.04	0.11
"	4	10	26	14	25	0.01	0.12
"	6	11	34	15 & 17	28	0.06	0.25
"	8	12	33	16	33	0.06	0.11
"	2	18	60	22	60	0.04	0.05
"	4	19	50	23	60	0.03	0.05
"	6	20	44	24	44	0.02	0.05
"	8	21	39	25	34	0.01	0.10
"	2	26	31	30	28	0.03	0.07
"	4	27	33	31	33	0.04	0.08
"	6	28	35	32	35	0.06	0.05
"	8	29	38	33	28	0.05	0.14
11/10/72	2	34	40	38	40	0.03	0.05
"	4	35	41	39	41	0.02	0.03
"	6	36	42	40	42	0.04	0.15
"	8	37	44	41	44	0.06	0.08
"	2	42	50	46	15	0.05	0.12
"	4	43	50	47	15	0.04	0.23
"	6	44	51	48	16	0.02	0.26
"	8	45	42	49	17	0.02	0.09

*Standards as promulgated by U.S. Department of Labor (Federal Register Part II, 1910.93)

TABLE IV

SULFUR DIOXIDE (SO_2)
(Standard 5 ppm)*

Date	Sampling Station	Sample Time (min)	Sample No	SO_2 ppm
11/9/72	1	420	1	< 0.01
"	3	420	2	<0.01
"	5	420	3	<0.01
"	7	420	4	<0.01
"	9	420	5	<0.01

*Standards as promulgated by U.S. Dept of Labor (Federal Register Part II, 1910.93)