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HEALTH HAZARD EVALUATION REPORT 72-108 - 46
HAZARD EVALUATION SERVICES BRANCH
DIVISION OF TECHNICAL SERVICES

Establishment	:	Electronics Corporation of America 1 Memorial Drive Cambridge, Massachusetts 02142
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Evaluation Conducted By	:	Robert Vandervort, Industrial Hygienist Phillip L. Polakoff, M.D., Medical Officer
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June 1973

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

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HEALTH HAZARD EVALUATION REPORT 72-108
ELECTRONICS CORPORATION OF AMERICA
CAMBRIDGE, MASSACHUSETTS

JUNE 1973

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 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 and gasoline engine exhaust gases emanating from an indoor loading dock facility at the Electronics Corporation of America, Cambridge, Massachusetts.

NIOSH investigators conducted an initial observational survey of this facility on December 21, 1972, and a follow up environmental-medical survey on April 3, 1973.

The substances which were judged to be of importance to this health hazard evaluation are listed below with appropriate occupational health standards promulgated by the U. S. Department of Labor (Federal Register, October 18, 1972, Title 29, Chapter XVII, Subpart G, Table G-1).

Substance	8-hour Time Weighted Average Concentration ppm*	mg/M^3**
Carbon Monoxide	50	55
Nitric Oxide	25	30
Nitrogen Dioxide	5	9

* Parts of vapor or gas per million parts of contaminated air by volume at 25^{o}c and 760 mmHg pressure.
** Approximate milligrams of substance per cubic meter of air.

Occupational health standards are established at levels designed to protect workers occupationally exposed to a substance on an 8-hour per day, 40-hour per week basis over a normal working lifetime.

Environmental sampling conducted in and around the indoor loading dock on April 3, 1973 using both continuous recording (sensitivity 1ppm) and spot sampling methods (sensitivity 5ppm) gave the following results. Carbon monoxide concentrations in the loading dock area averaged 9 ppm during 6.5 hours of normal truck activity at the loading dock. Carbon monoxide levels measured in adjacent work areas did not exceed 10 ppm on a spot sample basis. A new local exhaust system for removal of delivery truck engine exhaust and strict control of truck engine running time have been instituted prior to this survey. Thus the Towmotor servicing the loading dock was determined to be the current major source of carbon monoxide contamination. Carbon monoxide levels averaged approximately 20 ppm when the forklift was operating in the loading dock area.

Repeated spot sampling conducted in and around the indoor loading dock for nitric oxide and nitrogen dioxide failed to detect these substances. The spot sampling methods were capable of detecting levels of these two substances as low as 0.5 ppm.

Medically, it has been concluded from interviews with employees during both surveys, and discussions with union-management personnel that exposure to engine exhaust gases is not exerting a toxic effect on employees working in and around the indoor loading dock. The twenty-seven blood samples drawn from potentially exposed and non-exposed workers on April 3, 1973 could not be analyzed for carboxy hemoglobin (carbon monoxide in blood) due to a handling mishap. However, the available medical data was sufficient to permit evaluation of the potential hazard.

On the basis of environmental-medical investigations conducted during the months of December and April as reported above, it has been determined that engine exhaust gases (carbon monoxide, nitric oxide, and nitrogen dioxide) are not toxic at the concentrations measured in this plant.

Although the conditions evaluated at the time of our survey indicated no toxic effects, the potential for such could result if in the future trucks with horizontal exhaust pipes (which could not use the new exhaust system) must remain running in the loading dock area or if the now strict control of truck engine running time is relaxed.

Copies of this Summary Determination 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 have been sent to:

a) Electronics Corporation of America, Cambridge, Massachusetts

b) Authorized Representative of Employees

c) U.S. Department of Labor - Region I

For the purposes of informing the approximately 30 "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 concentrations 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 and gasoline engine exhaust fumes emanating from an indoor loading dock facility at the Electronics Corporation of America, Cambridge, Massachusetts. (See Figure 1, Sec. VII)

This company is engaged in the manufacturing of combustion control equipment and infra-red photo switching equipment (which provides automatic control for many industrial processes and manufacturing activities, i.e., counting, bottling, controlling, routing, starting, guiding, etc.).

III. BACKGROUND HAZARD INFORMATION

A. Standards

The occupational health standards promulgated by the U. S. Department of Labor (Federal Register, October 18, 1972, Title 29, Chapter XVII, Subpart G, Table G-1) applicable to the substances of the evaluation are as follows:

Substance	8-Hour Time Weighted Average Concentration ppm*	mg/M^3**
Carbon Monoxide	50	55
Nitric Oxide	25	30
Nitrogen Dioxide	5	9

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

** Approximate milligrams of substance per cubic meter of air.

Occupational health standards are established at levels designed to protect workers occupationally exposed to a substance on an 8-hour per day, 40-hour per week basis over a normal working lifetime.

B. Toxic Effects

Diesel and gasoline engine exhaust gases are the two major components that comprise the potential hazard in this specific health hazard evaluation. In particular, carbon monoxide and oxides of nitrogen are of most concern.

1. Diesel, Gasoline and Propane Engine Exhaust Emissions

Diesel exhaust may be described as a mixture at the source of approximately 98% air containing a higher than normal fraction of carbon dioxide and of water, and a small portion of an extremely complex combustion mixture.[1] Nitrogen oxides, aldehydes, several hydrocarbons and sometimes sulfur dioxide are the major toxic components of this very minor fraction. Some carbon moxide can also be present in a measurable, although quite limited amount which is in contrast to the high concentration usually present in gasoline engine exhaust. The diesel, like all other internal combustion engines, has exhaust which is far from being of constant composition. The final make-up of the exhaust is dependent in part on the type of diesel fuel, the revolutions per minute and the load at which the engine is operated, the engine's design, and the efficiency of the engine with respect to the previously mentioned variables. One must further add the factors of ventilation, numbers of engines operating within a confined space, and the like to define the details of diesel pollution.

The question of health hazards originating from diesel exhaust has been the concern of many over the past several decades. The objectionable quality of gases discharged by diesel engines, their pungent odor and the bluish black smoke which often characterizes this exhaust, have suggested in the minds of many observers a strong connotation of harmfulness.[2]

Toxicology studies on animals exposed to undiluted diesel exhaust gases for prolonged time have shown toxic effects in the respiratory tract varying in severity up to the extreme of death.[3]

Clinical observations are scanty and mostly negative in regard to effects ascribable to diesel exhaust exposure. The most definitive chemical study done on diesel exhaust was performed by Battigelli on locomotive repairmen. This investigator's findings are summarized as follows: "Within the limits of exposure to diesel exhaust products, of locomotive repairmen in three representative railroad engine houses over a period up to 15 years (average duration - 10 years) 210 workers (average age - 50 years) did not show any significant difference in pulmonary function performance from a group of 154 railroad yard workers (average age - 50 years) of comparable job status but without history of exposure to diesel exhaust products."[1]

Gasoline fueled engine exhaust consists mainly of carbon monoxide. Present in smaller amounts are hydrocarbons, nitrogen oxides, particulates, sulfur oxides, aldehydes and organic acids. (See Table I, Sec. VII).[4] Propane engine emissions have a similar composition.

Carbon monoxide is the most important contaminant.

2. Carbon Monoxide

Carbon monoxide (CO) is an odorless, colorless, tasteless gas generally produced by incomplete oxidation of organic or carbonanceous material (See Table II, Sec. VII for physical properties).[5] Frequently, but not invariable, it is accompanied by the odor of other organic by-products of combustion.

Carbon monoxide exerts its harmful effect by combining reversibly with hemoglobin which has a greater affinity for carbon monoxide than for oxygen. The reduction in the oxygen carrying capacity of the blood which may progress to a state of tissue hypoxia is proportional to and dependent upon the percentage of saturation with CO or the amount of carboxy hemoglobin present in the blood.[6]

The blood of cigarette smokers will contain from 2% to 10% carboxy hemoglobin and non-exposed adults will show a normal average background of 1% carboxy hemoglobin.

There are three types of carbon monoxide poisoning: (1) acute asphyxiation, (2) Acute asphyxiation with sequelae, and (3) Chronic exposure.

(1) Acute asphyxiation has associated symptoms which may vary in severity, being dependent upon the concentration of the gas, length of exposure, the activity or inactivity of the patient and possibly individual susceptability. Headaches, dizziness and nausea occur early with a weakness of the leg muscles which causes the individual to fall. Such symptoms make their appearance when level of carboxy hemoglobin reaches 20 to 30 per cent.[7] The individuals skin color changes as the condition progresses. At first the individual appears pale but this may gradually change until the skin and mucous membraines become cherry red, even after respiration has ceased. Survivors of near fatal poisonings have related a throbbing type of headache with roaring in the ears, confusion and general weakness preceeding unconsciousness. Unconsciousness occurs when nearly half the hemoglobin is bound by CO. It is believed that CO is eliminated within twelve to twenty-four hours. The duration of exposure is more important than the concentration of CO in the air in determining the severity of symptoms and production of disabling sequelae.

(2) Acute asphyxiation with Sequelae - Symptoms and neurologic changes may be noticed immediately or the changes may be so subtle that there may be a delay of from a few days to several weeks in their recognition. Headaches and dizziness may ensue and persist. Visual deficiency or blindness may be present, twitching, choreiform movements or convulsive seizures may have occurred. Apathy, disinterest, dulled memory, lack of judgement, and in fact the whole gamit of mental changes have been noted.

In addition, to the effect upon the central nervous system, pneumonia may set in within a few days following acute exposure. Also there are references in the literature to complications following hemorrhage into the kidneys, spleen or liver. Permanent damage to the heart is unlikely.[8]

(3) Chronic Effects - The well known effects of prolonged exposure to carbon monoxide are no different from the acute effects: headache, nausea, impaired senses, general debility weakness, vertigo and alazia. Increase in hemoglobin and red cells as well as many more obscure effects have been attributed to chronic poisoning, some of them being reputed sequelae of acute poisoning as well.[9]

A convincing study of the absence of any signs of chronic carbon monoxide poisoning, especially where exposures are too low to cause acute symptoms, has been reported by Seevers, Edwards, Murray, and Schrenk.[10] The study involved clinical and laboratory examinations of 156 traffic officers stationed in the Holland Tunnel in New York. These men had been on duty 13 years in an exposure which averaged 65 to 85 ppm carbon monoxide from exhaust emmissions and the carboxy hemoglobin in their blood ranged from 0.5 to 13.1 per cent. They were found to be in exceptionally good physical condition.

The NIOSH criteria document on carbon monoxide recommends the following:

a) Occupation exposure to carbon monoxide shall be controlled so that no worker shall be exposed at a concentration greater than 35 ppm determined as a time weighted average (TWA) exposure for an 8-hour work day, as measured with direct reading, hopocalite type, portable carbon monoxide meter calibrated against known concentrations of CO.

b) No level of carbon monoxide to which workers are exposed shall exceed a ceiling concentration of 200 ppm.

3. Oxides of Nitrogen (present as nitrogen dioxide and nitric oxide can be found in significant amounts in gasoline engine exhaust emissions.)

(1) Nitrogen dioxide is a primary irritant. Acute exposures to concentrations of 10 to 20 ppm produce symptoms of eye, nose, and upper respiratory tract irritation. Exposure to potentially lethal concentrations in the range of 50 ppm or greater may produce no symptoms for as long as 8 hours at which time symptoms of acute pulmonary edema appear. Continuous chronic exposure to concentrations greater than 5 ppm may produce progressive and possibly fatal pulmonary edema and hemorrhage. The evaluation of nitrogen dioxide toxicity is easily confused because of the frequent simultaneous presence of nitric oxide and ozone. Chronic exposure may lead to build up of methemoglobin in the blood, which can be an indicator of exposure. The current exposure standard as promulgated by the U. S. Department of Labor (Federal Register, Volume 37, § 1910.93, October 18, 1972) is expressed as an 8 hour time weighted average (TWA) exposure of 5 ppm. The American Conference of Governmental Industrial Hygienists has adopted 5 ppm of nitrogen dioxide as a ceiling exposure standard. They contend that employees should never be exposed to concentrations of nitrogen dioxide in excess of 5 ppm.

(2) Nitric oxide, also a component of internal combustion engine exhaust emissions, is converted spontaneously in air to nitrogen dioxide. However, this reaction proceeds slowly at concentrations less than 50 ppm of nitric oxide. It causes symptomatology similar

to that of nitrogen dioxide, but is felt to be less toxic. The current exposure standard as promulgated by the U. S. Department of Labor (Federal Register, Volume 37, § 1910.93, October 18, 1972) is expressed as an 8-hour time weighted average (TWA) exposure of 25 ppm.

IV. HEALTH HAZARD EVALUATION

A. Observation Survey

On December 21, 1972, Mr. Robert Vandervort and Phillip L. Polakoff arrived in Cambridge, Massachusetts in response to a health hazard request submitted by Mr. Paul F. Walker, department steward, I.U.E., AFL-CIO, Local No. 272. The alleged hazard was exposure to exhaust fumes emitted from diesel and gasoline fueled trucks parked in an enclosed unloading area. Approximately 20-25 workers had reported complaints of headaches and nausea which they believed were caused by exposure to exhaust fumes.

Upon Arrival at the plant the NIOSH representatives met with the following persons:

Mr. John Beystehner - Production Manager, ECA
Mr. Robert Gellatly - Personnel Director, ECA
Mr. Wes Clifford - President, Local 272, International Union of Electrical, Radio, and Machine Workers, AFL-CIO
Mr. James Duarte - Chief Steward
Mr. Paul Walker - Steward (Requester)

In the discussion that ensued, the request and NIOSH's responsibility in evaluating the alleged hazard was explained.

Following this preliminary meeting, the NIOSH representatives examined the enclosed loading dock area. Several employees were interviewed and the following description of the problem was obtained.

The enclosed loading dock area (See Figure 1, Section VII) services on an average of 3 to 4 diesel fueled and 10 to 14 gasoline fueled trucks per day. These trucks back up to the dock and load or unload their respective cargoes. Trucks can remain on the dock for periods of a few minutes to over an hour. In general, it was reported that trucks have kept their engine's running while at the dock. Some of the trucks are equipped with power take-off devices which require their engines to remain running. In addition to the trucks, there is one propane powered Towmotor forklift which operates semi-continuously in this area.

Since the enclosed loading area has no provision for exhausting the emissions from the delivery trucks and forklift these emissions allegedly contaminate the dock area and adjacent work areas as well.

According to Mr. John Beystechner, Production Manager, the excess diesel and gasoline exhaust in the area first became a problem in June, 1971 when concrete trucks were left running while a new garage floor was being poured. Mr. Wes Clifford, now the former president of the local union, stated that diesel and gasoline exhaust has been the cause of many complaints for the past four to five years. Much time has been spent in labor-management safety meetings discussing this alleged hazard. Not until November, 1972 did the Company try to rectify the alleged hazard. At that time a policy was initiated whereby a 4 inch diameter flexible hose was attached to the exhaust pipes of those trucks which had to use their engines at the dock. (See Photo No. 1, Section VII) This hose, approximately 30 feet in length, communicated with the outside through an opening in an elevated window. There was no mechanical air mover associated with the hose to facilitate the removal of exhaust gases. A week prior to our visitation the company started to enforce a policy whereby gasoline trucks could not keep their engines running while at the dock.

Other details regarding alleged exposure to exhaust gases in or from the loading dock area will be handled in the environmental and medical sections of the report.

Due to the severity of the weather conditions on the day of our initial visition (subfreezing temperatures, snow showers, icy roads), no trucks made pickups or deliveries at the inside loading dock. This situation obviously precluded the gathering of representative exposure data since the trucks and the assisting forklift are the only probable sources of contamination in this area.

In an exit interview with plant management and union representatives, the plant stated its intention to install a much improved local exhaust system for the inside loading dock area. They stated that this control equipment could be installed almost immediately and that until installation was complete strict control of truck running time in the inside loading dock area would be exercised. With the concurrence of both union and plant representatives it was decided that NIOSH would delay its environmental-medical evaluation of exposures in this area until the new controls could be installed.

B. Environmental Evaluation

1. Background Information

Careful examination of the indoor loading dock area and adjoining work areas, where most employee complaints have been registered, did reveal several important facts. (Refer to Figure 1, Sec. VII)

During the winter months the roll-up door which opens directly to Main Street is kept closed except open as necessary to permit entrance and exit of delivery vehicles. The physical dimensions of the loading dock area permit only one vehicle to park at the dock at a time, but as many as three vehicles may line up in front of the docked vehicle. The unloading or loading times for the assorted vehicles is highly variable (a few minutes to over an hour). The diesel fueled truck with power tailgate which delivers bottled gases to the plant was reported to be the worst offender.

A propane powered forklift usually operates in this area during truck unloading and until arriving materials are properly transported to appropriate areas of the plant.

Ventilation for the inside loading dock area is strickly general in nature. It is not provided with a separate air supply and exhaust system, but is serviced by the main plant ventilation system. Air flows patterns in loading dock area are strongly influenced by large exhaust fans located in departments 804 and 808 to the left of the dock area in Figure 1, Section VII. These fans move very large volumes of air and are not properly balanced with makeup air units. As a result air is drawn to these exhaust fans from other areas of the plant, including the loading dock area. Figure 2, Section VII illustrates air flow patterns in the dock area as determined by the use of smoke tubes. From the figure it is readily apparent that exhaust gases emitted in the loading dock area would find their way to adjacent work areas.

After confirming that new environmental controls were operating, Mr. Vandervort and Dr. Polakoff returned to the E.C.A. plant on April 3, 1973 to conduct a complete environmental-medical evaluation.

Figure 3, Photo No.2, and Photo No. 3, Section VII show the new local exhaust equipment. In practice, a portable hood is placed over the vertical exhaust pipe of the delivery truck. (See Photo No. 4, Section VII) Exhaust gases are drawn into the hood, through the flexible and rigid ductwork to the fan and then discharged to the outdoors. It should be noted that this new exhaust from vehicles which have horizontal exhaust pipes and which must remain running. Horizontal exhaust pipes are usually located beneath and toward the rear of vehicles and could not be reached by the portable hood.

In addition to the local exhaust equipment, E.C.A. will be installing an air curtain at the roll-up door which opens to Main Street. (See Photo No. 5, Section VII) This air curtain will use fresh tempered air and will help to balance the negative pressure in the indoor loading dock area while at the same time providing warmth to the dock area during winter months.

2. Sampling Procedure and Equipment

Concentrations of carbon monoxide and nitrogen oxides in the air were measured in and around the loading dock area. A variety of air sampling equipment was employed. Carbon monoxide concentrations were continously measured and recorded by a Model 2100 ECOLYZER Portable Carbon Monoxide Monitor linked to a Model T 171 B Esterline-Angus portable strip chart servo recorder. The Model 2100 ECOLYZER has a response time of approximately thirty seconds with an accuracy of ± 1% or ± 1 ppm between 0 and 100 ppm. The ECOLYZER was calibrated in Cincinnati on April 2, 1973, checked with span gas (53 ppm CO) in the field at E.C.A. April 3, 1973, and recalibrated in Cincinnati on April 4, 1973. Deviation in calibration was found to be less than ± 1 ppm for the period April 2 to April 4, 1973.

Carbon monoxide concentrations measured by the ECOLYZER and subsequently recorded on strip-chart paper are included in Appendix A, Section VIII. Appendix B, Section VIII contains a log of the activity in the loading dock area during the sampling period (approximately 8:30 A.M. to 3:00 P.M., April 3, 1973). During the sampling period the ECOLYZER with its accompanying recorder were stationed on the loading dock platform adjacent to the small stairway.

In addition to continuously monitoring carbon monoxide concentrations in the loading dock area, carbon monoxide, nitrogen dioxide, and nitrogen dioxide plus nitric oxide concentrations were measured at spaced intervals (approximately every two hours) in the loading dock area and in work areas adjacent to the loading dock area. These measurements were made using gas detector tubes. Carbon monoxide was measured using Drager Carbon Monoxide Detector Tubes, range 5-150 ppm. Nitrogen dioxide was measured using Drager Nitrogen Dioxide Detector Tubes, range 0.5-10 ppm. Nitrogen dioxide plus nitric oxide was measured using Drager Nitrous Fumes Detector Tubes, range 0.5-10 ppm.

3. Results

The carbon monoxide concentrations measured by the ECOLYZER are presented in Appendix A, Section VIII. As can be seen from the data, the Towmotor is by far the most significant source of carbon monoxide contamination. Over the sampling period the carbon monoxide concentration at the loading dock averaged 9 ppm. During periods when the Towmotor was operating the average carbon monoxide concentration was approximately 20 ppm.

Carbon monoxide concentrations are determined by detector tube measurements in the dock area and in adjacent work areas ranged from 5-10 ppm. No detectable levels (i.e. larger than 0.5 ppm) of nitrogen dioxide or nitrogen dioxide plus nitric oxide were measured by detector tube sampling in the loading dock area or in adjacent work areas.

4. Conclusions

Toxic concentrations of carbon monoxide, nitrogen dioxide, and nitrogen dioxide plus nitric oxide were not found in the loading dock area or in adjacent work areas during normal operations of the loading dock on April 3, 1973.

The installation of improved ventilation control for engine exhaust removal and the institution of strict control of truck engine running time in the indoor unloading dock area has resulted in satisfactory control of employee exposures to gasoline and diesel engine exhaust gases.

5. Recommendations

It is strongly recommended that delivery trucks continue to use the new exhaust system and that the strict control of truck engine running time be maintained.

Should trucks with horizontal exhaust pipes be required to keep their engines running in this area, modification of the new exhause system would have to be made to afford adequate control of emissions from these types of vehicles.

C. Medical Evaluation

To ascertain the severity of the alleged exposures to exhaust gases from gasoline and diesel engines, employees were interviewed during both the initial observational survey and the environmental-medical survey.

From the initial observational survey it was determined that 25 to 30 individuals were possibly affected by exposure to engine exhaust gases. Those affected consisted of painters, finishers, packers, drill press operators, welders, shippers, receivers, and movemen. All these individuals work in areas surrounding the loading dock area. Fourteen workers were interviewed, and all gave a like medical history. They complained of headaches, a nauseated feeling, no vomiting, light headedness or dizziness and a general sensation of body discomfort when the garage door was closed and truck engines were kept running. This situation reportedly occurred most frequently during winter months. None of the workers interviewed had ever missed work because of the alleged hazard nor have any seen the company physician. Reportedly, when the exhaust exposures have become intolerable, workers have stepped outside for fresh air.

The severity of the alleged hazard was discussed with the company nurse, Mrs. Lillian Ehlers. She felt that workers have been exposed to excessive levels of engine exhaust gases. Workers have complained to her about the above stated medical symptomatology. The company physician was not aware that the problem existed.

No physical examinations were performed on any of the workers.

On the followup environmental-medical survey, it was planned to conduct biological sampling of an adequate representation of the alleged affected individuals and to further interview them with regard to persistent adverse symptomatology resulting from exposure to exhaust gases.

Pre-shift and post-shift blood samples were drawn from seven potentially exposed and six non-exposed individuals (serving as controls). Unfortunately, during transit all twenty-six samples became clotted which prevented the NIOSH analytical laboratory from analyzing these samples for carboxy hemoglobin levels.

None of the individuals from whom the blood was drawn stated that they suffered any adverse symptomatology on the day of the survey. Their consensus of opinion was that the improved ventilation has lessened exposures to engine exhaust gases.

Based on a thorough walk-through inspection of the involved areas, interviews with a majority of employees who have had medical complaints, and conservations with company officials, it is concluded that in the past situations might have arisen whereby a sizeable number of employees were exposed to engine exhaust gases which caused them undue discomfort and had the potential to cause the symptoms that they previously complained of. With the addition of new ventilation and stricter engine operating procedures, the potential hazard no longer exists.

D. Conclusions

On the basis of environmental-medical investigations conducted during the months of December and April, it has been determined that engine exhaust gases (carbon monoxide, nitric oxide, and nitrogen dioxide) are not toxic at the concentrations measured in this plant.

Although conditions evaluated at the time of our survey indicated no toxic effects, the potential for such could result if in the future trucks with horizontal exhaust pipes (which could not use the new exhaust system) must remain running in the indoor loading dock area or if the now strict control of truck engine running time is relaxed.

V. RECOMMENDATIONS

It is strongly recommended that delivery trucks continue to use the new exhaust system and that the strict control of truck engine running time be maintained.

Should trucks with horizontal exhaust pipes be required to keep their engines running in this area, modification of the new exhaust system would have to be made to afford adequate control of emissions from these types of vehicles.

Workers with persistent complaints should report these promptly to the plant physician for medical evaluation.

VI. REFERENCES

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VII. FIGURES, PHOTOS, AND TABLES

Figure 1

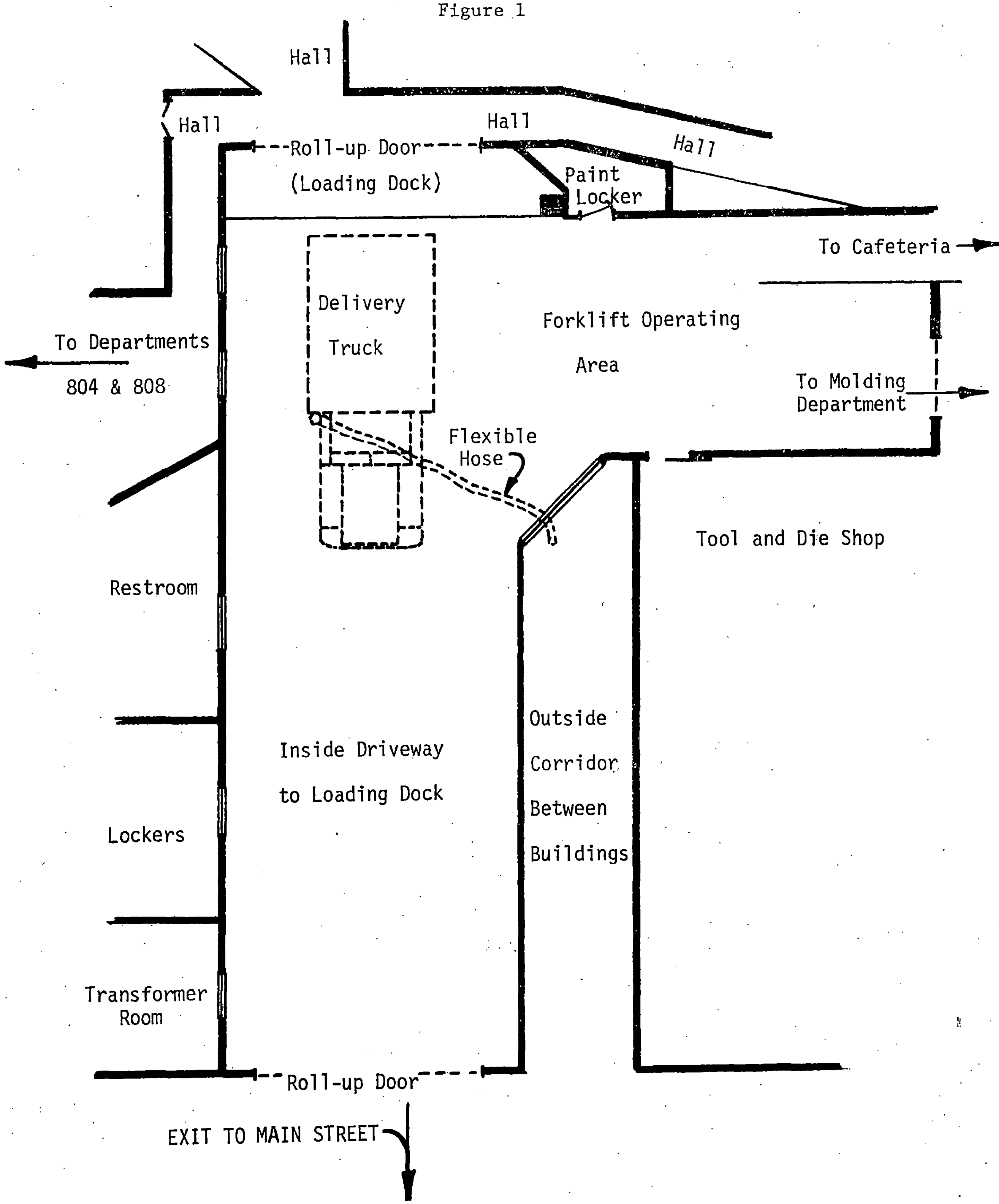


Figure 2

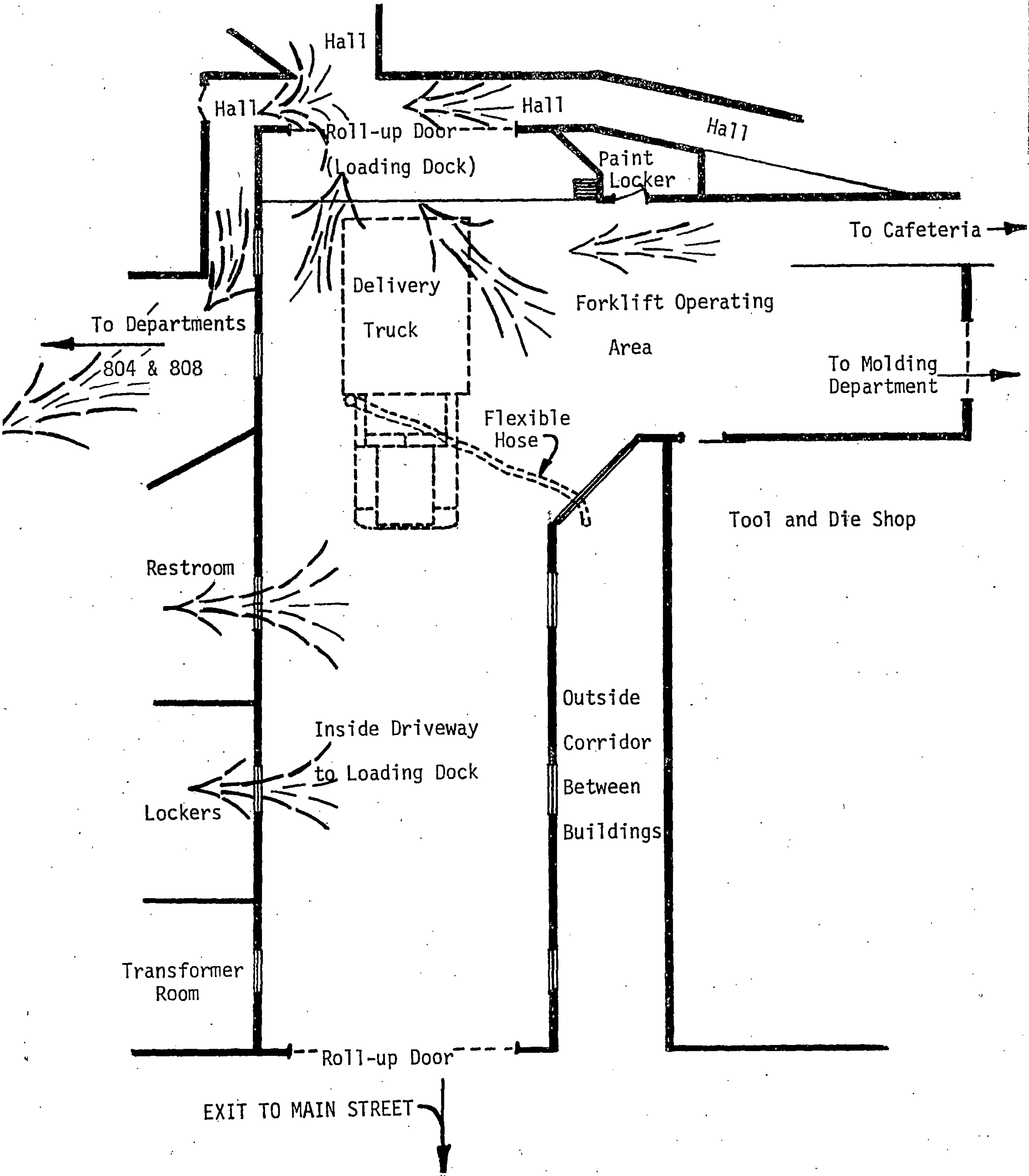
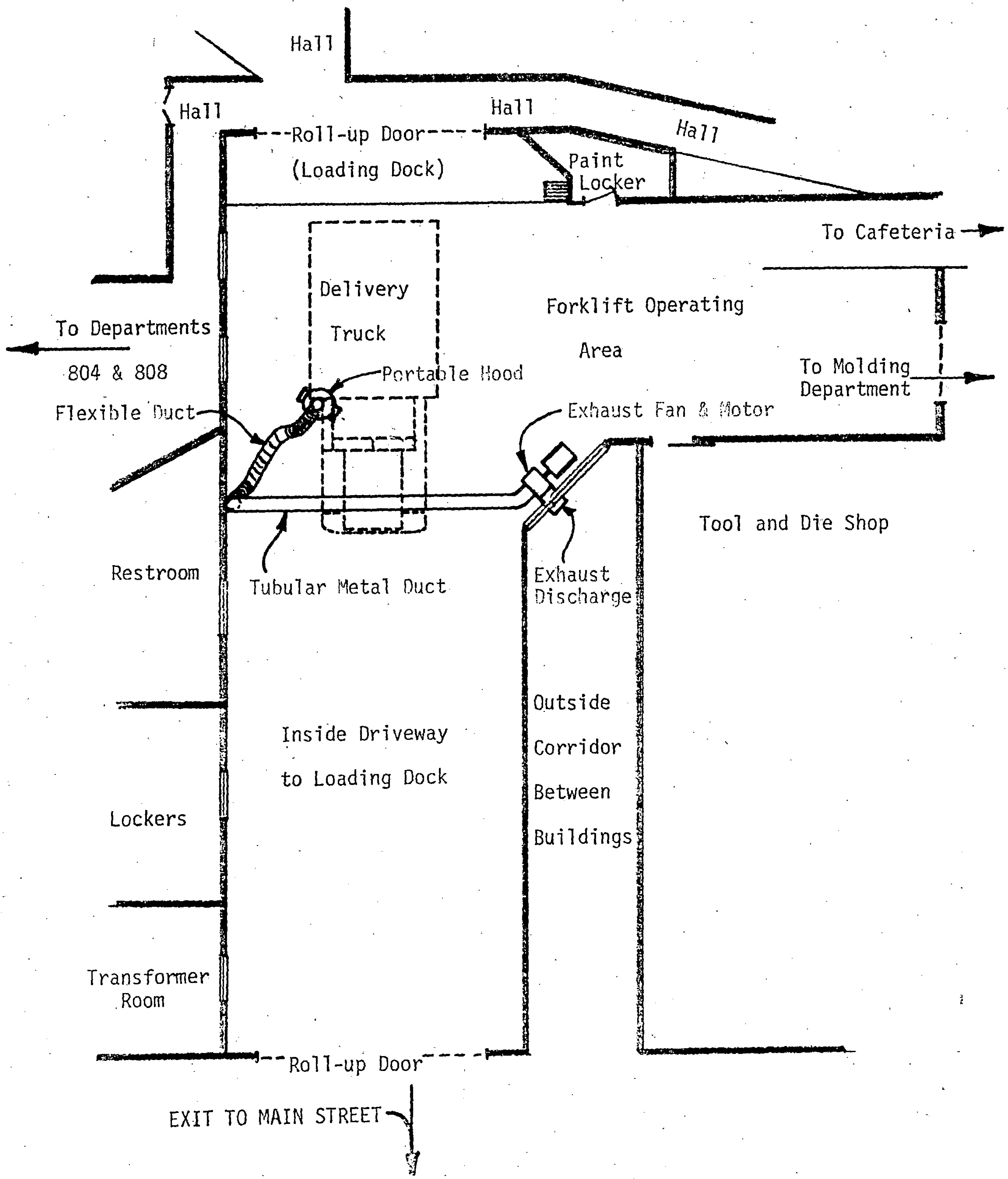

Hall
Hall
Hall
Hall
Roll-up Door
(Loading Dock)
Paint
Locker
To Cafeteria
Delivery
Truck
Forklift Operating
Area
To Departments
804 & 808
To Molding
Department
Flexible
Hose
Tool and Die Shop
Restroom
Outside
Corridor
Between
Buildings
Inside Driveway
to Loading Dock
Lockers
Transformer
Room
Roll-up Door
EXIT TO MAIN STREET

Figure 3


Hall
Hall
Hall
Hall
Roll-up Door
(Loading Dock)
Paint Locker
To Cafeteria
Delivery Truck
Forklift Operating Area
To Departments 804 & 808
Portable Hood
To Molding Department
Flexible Duct
Exhaust Fan & Motor
Tool and Die Shop
Restroom
Tubular Metal Duct
Exhaust Discharge
Outside Corridor Between Buildings
Inside Driveway to Loading Dock
Lockers
Transformer Room
Roll-up Door
EXIT TO MAIN STREET

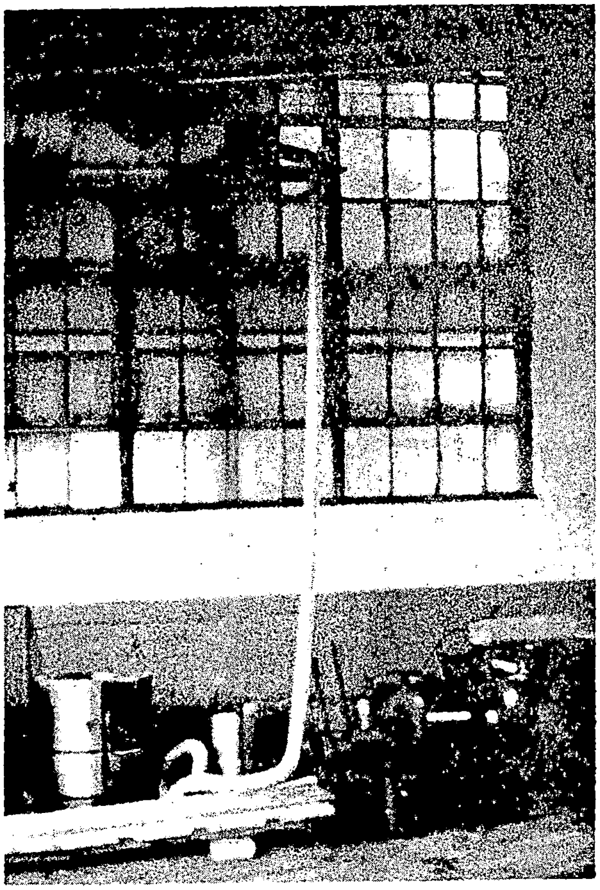


PHOTO NO. 1: Flexible hose with no mechanical air mover to remove exhaust gases.

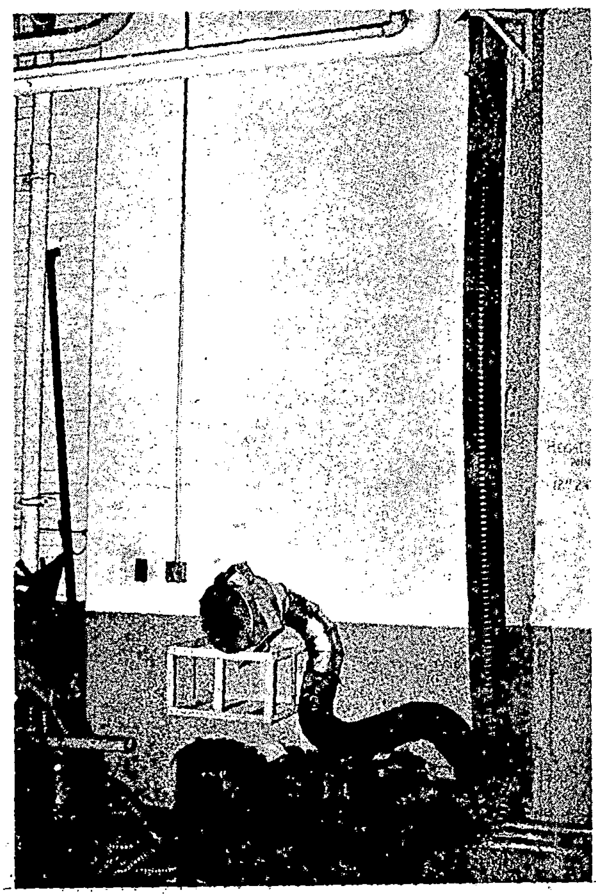


PHOTO NO. 2: New exhaust gas control hood. Hood shown as it is stored between uses.

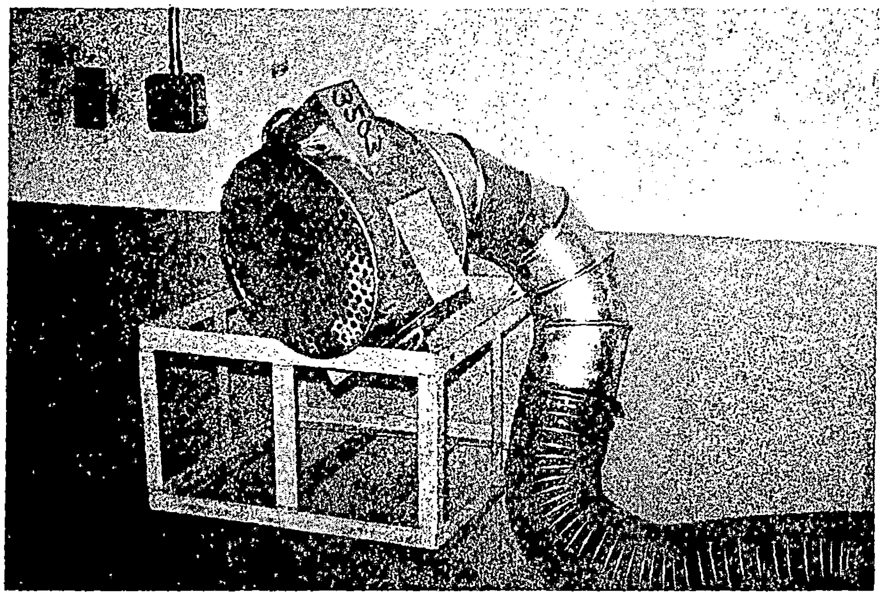


PHOTO NO. 3: Close-up of new engine exhaust control hood.

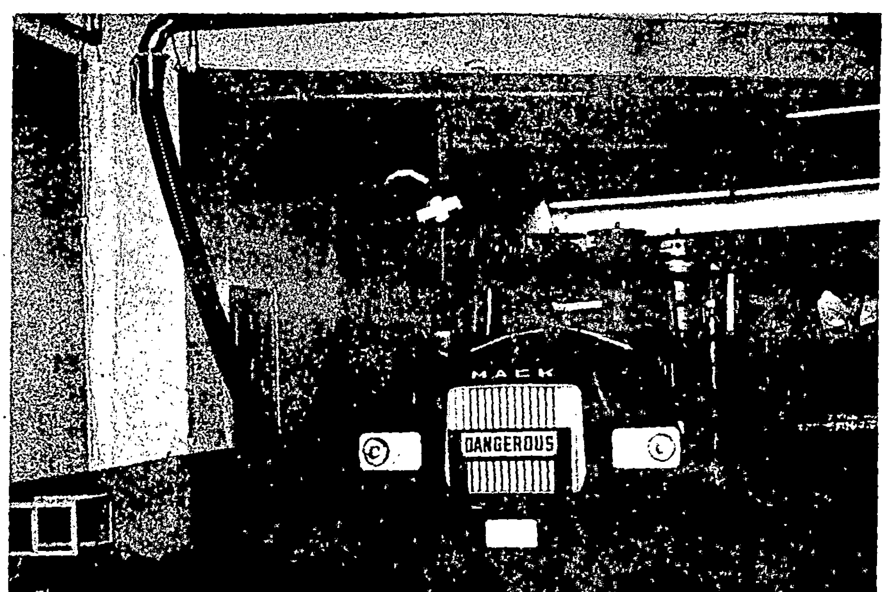


PHOTO NO. 4: New exhaust gas control hood in operation. In this case a diesel fueled truck is unloading.

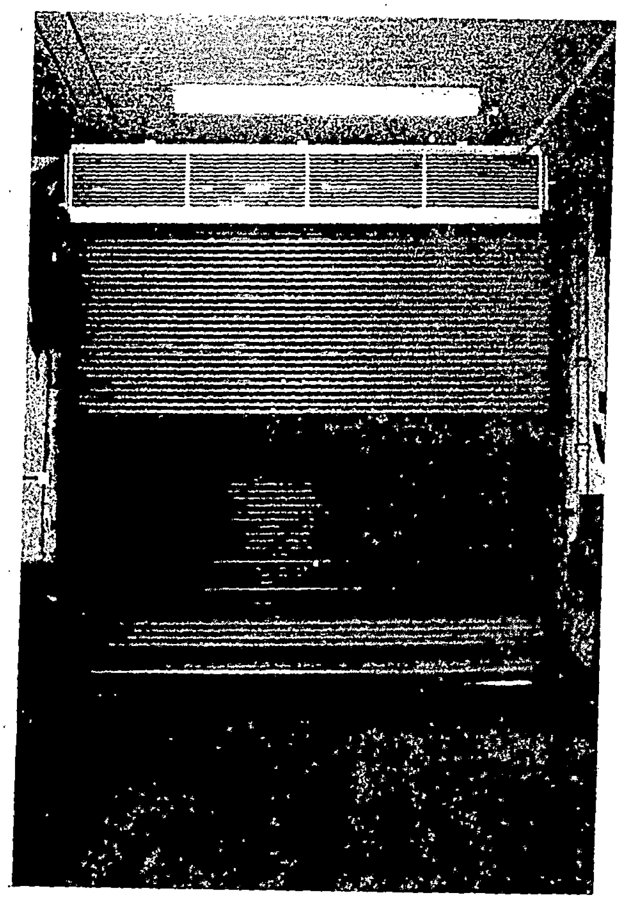


PHOTO NO. 5: New air curtain equipment above roll-up door.

Table I: EMISSION FACTORS FOR GASOLINE-POWERED MOTOR VEHICLES[a]
EMISSION FACTOR RATING: A

Emissions	1960		1965		1970		1971		1972		1973		1974		1975	
	g/mi	g/km	g/mi	g/km	g/mi	g/km	g/mi	g/km	g/mi	g/km	g/mi	g/km	g/mi	g/km	g/mi	g/km
Carbon Monoxide																
Urban	120	74.5	120	74.5	95	59.0	90	56.0	85	52.8	80	49.7	75	46.6	60	37.2
Rural	70	43.5	70	43.5	60	37.3	55	34.2	50	31.0	45	28.0	40	24.8	25	21.7
Hydrocarbons																
Evaporation	2.7	1.68	2.7	1.68	2.7	1.61	2.3	1.43	2.3	1.43	1.8	1.12	1.8	1.12	1.4	0.87
Crankcase[b]	4.1	2.54	2.7	1.68	0.9	0.56	0.45	0.28	0.45	0.28	0.32	0.2	0.22	0.14	0.22	0.14
Exhausts																
Urban	16	10.0	16	10.0	12	7.45	11	6.83	9.5	5.9	8.5	5.28	7.2	4.5	6	3.72
Rural	10.5	6.53	10.5	6.53	8	5.0	7	4.35	6.5	4.04	6	3.72	5	3.10	4	2.48
Nitrogen Oxide (NO_x as NO_2)	6.58	4.1	6.60	4.1	6.63	4.12	6.47	4.02	6.17	3.83	5.75	3.57	5.55	3.45	4.90	3.04
Particulates[c]	0.3	0.19	0.3	0.19	0.3	0.19	0.3	0.19	0.3	0.19	0.3	0.19	0.3	0.19	0.1	0.062
Sulfur Oxides (SO_2)[d]	0.18	0.11			No legislation is in effect or has been proposed for these pollutants, and thus only one factor is presented.											
Aldehydes (HCHO)	0.36	0.224														
Organic acids (acetic)	0.13	0.081														

[a] To convert emission factors to grams/gallon (kg/10^3 liters), assume the average gasoline-powered engines get 12.5 miles/gallon (5.3 km/liter).

[b] Crankcase emissions for vehicles after 1962 are neglible. These factors are based on pre-1962 vehicles left in the vehicle population.

[c] Urban factor=rural factor.

[d] Based on sulfur content of 0.04 percent and a density of 6.17 lb/gallon (0.74 kg/liter).

Updated to reflect revised test cycle and test procedures current in July 1971.

Table II

PHYSICAL CHARACTERISTICS OF CO[4]

Molecular weight	28.01
Melting point	-207°C
Boiling point	-192°C
Specific gravity relative to air	0.968
Density	
At 0°C, 760 mm Hg	1.25 g/liter
At 25°C, 760 mm Hg	1.15 g/liter
Explosive limits in air	12.5 to 74.2% (volume)
Solubility[a]	
At 0°C	3.54 ml/100 ml water
At 25°C	2.14 ml/100 ml water
Conversion factors	
At 0°C, 760 mm Hg	1 mg/m^3 = 0.800 ppm
	1 ppm = 1.250 mg/m^3
At 25°C, 760 mm Hg	1 mg/m^3 = 0.874 ppm
	1 ppm = 1.145 mg/m^3

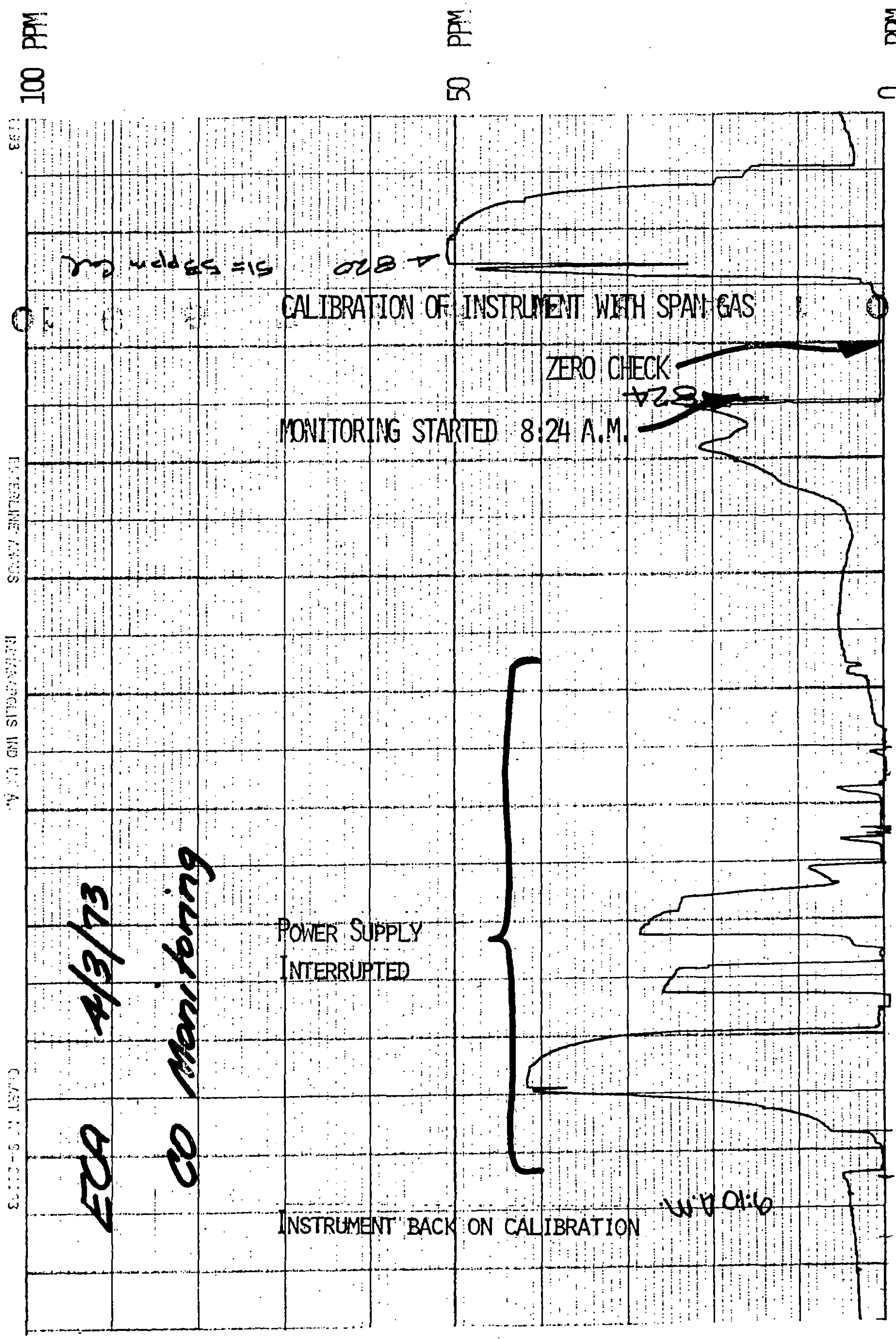
[a] Volume of CO indicated is at 0°C, 760 mm Hg.

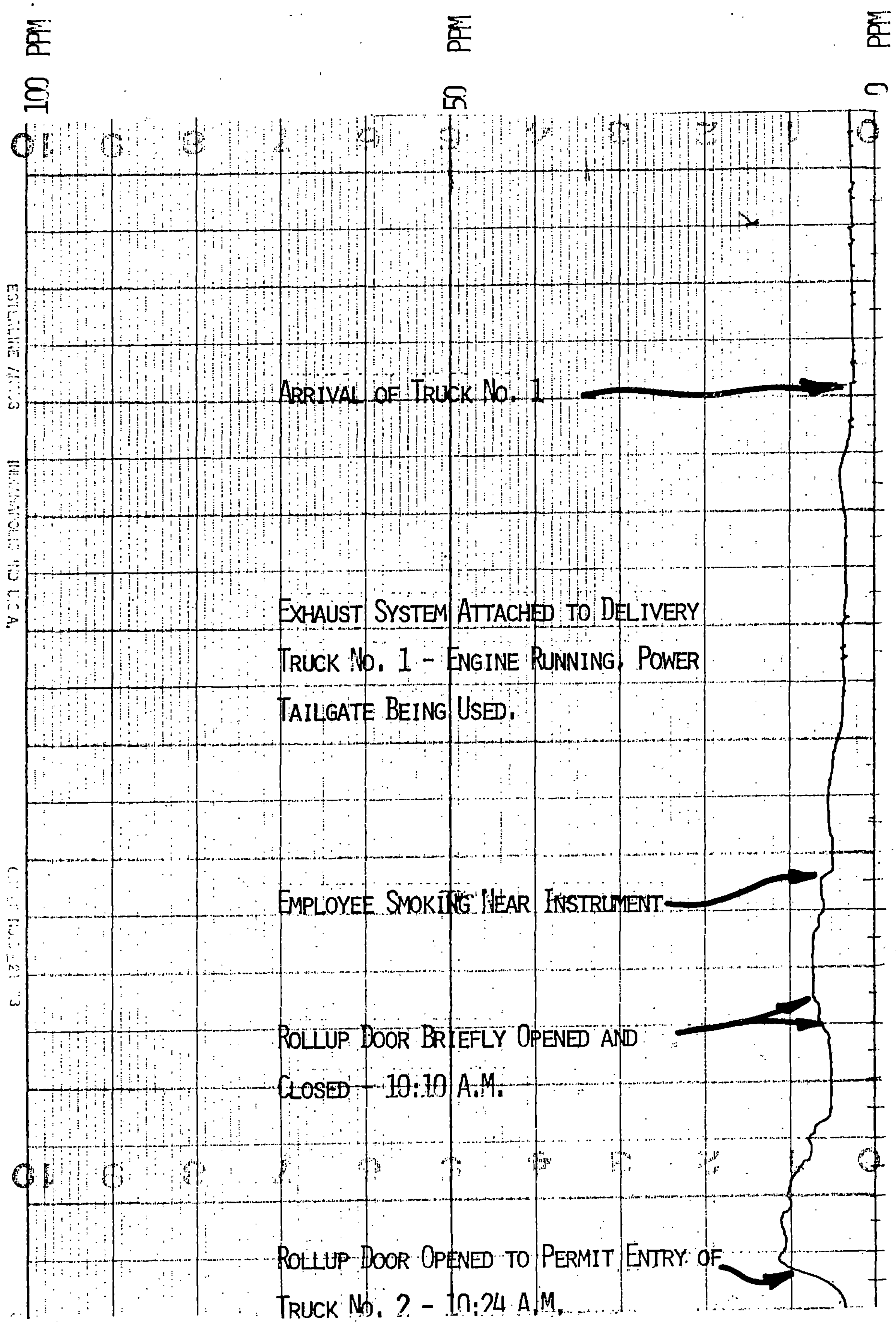
Table III

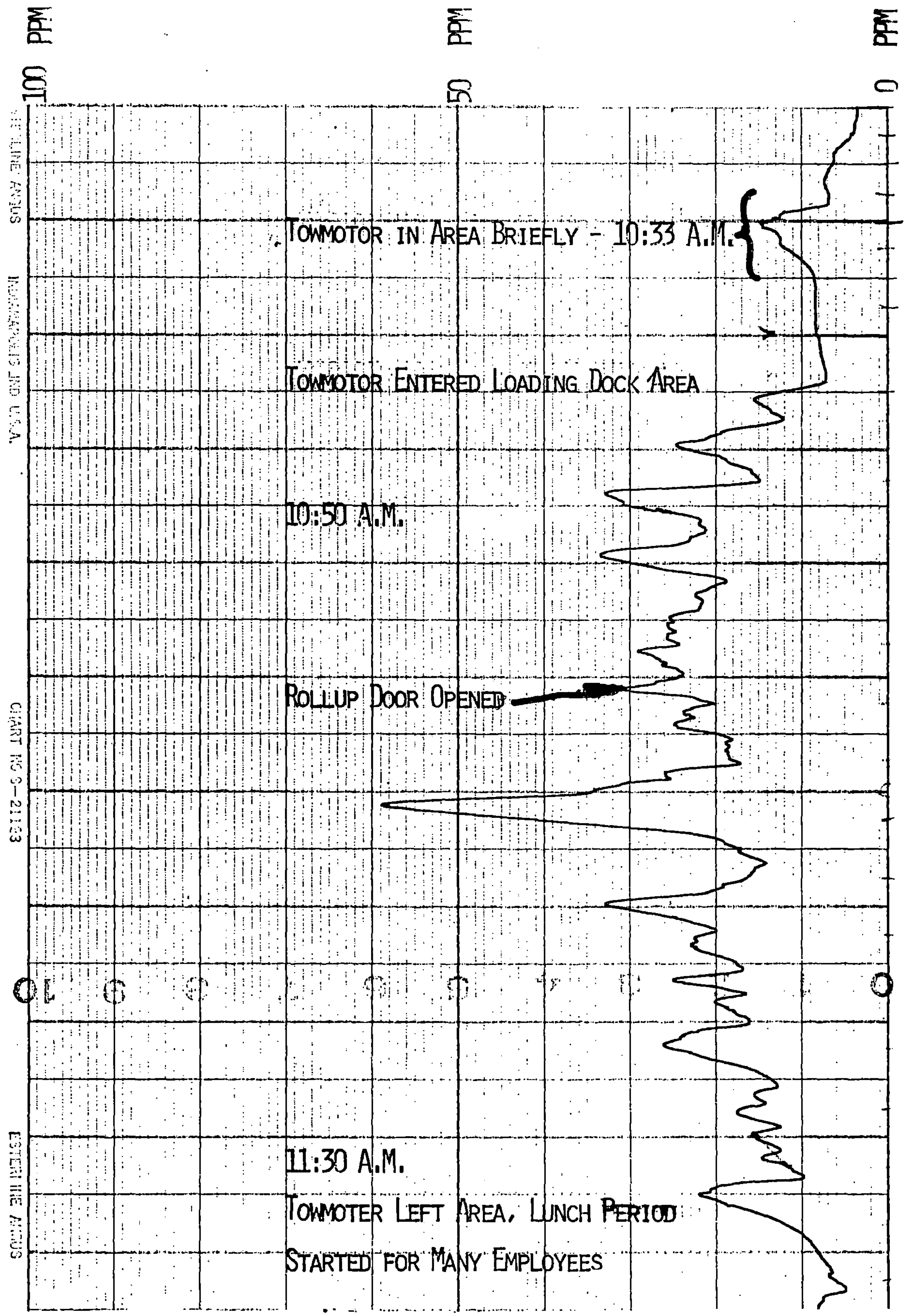
SYMPTOMS CAUSED BY VARIOUS AMOUNTS OF CARBON MONOXIDE HEMOGLOBIN IN THE BLOOD

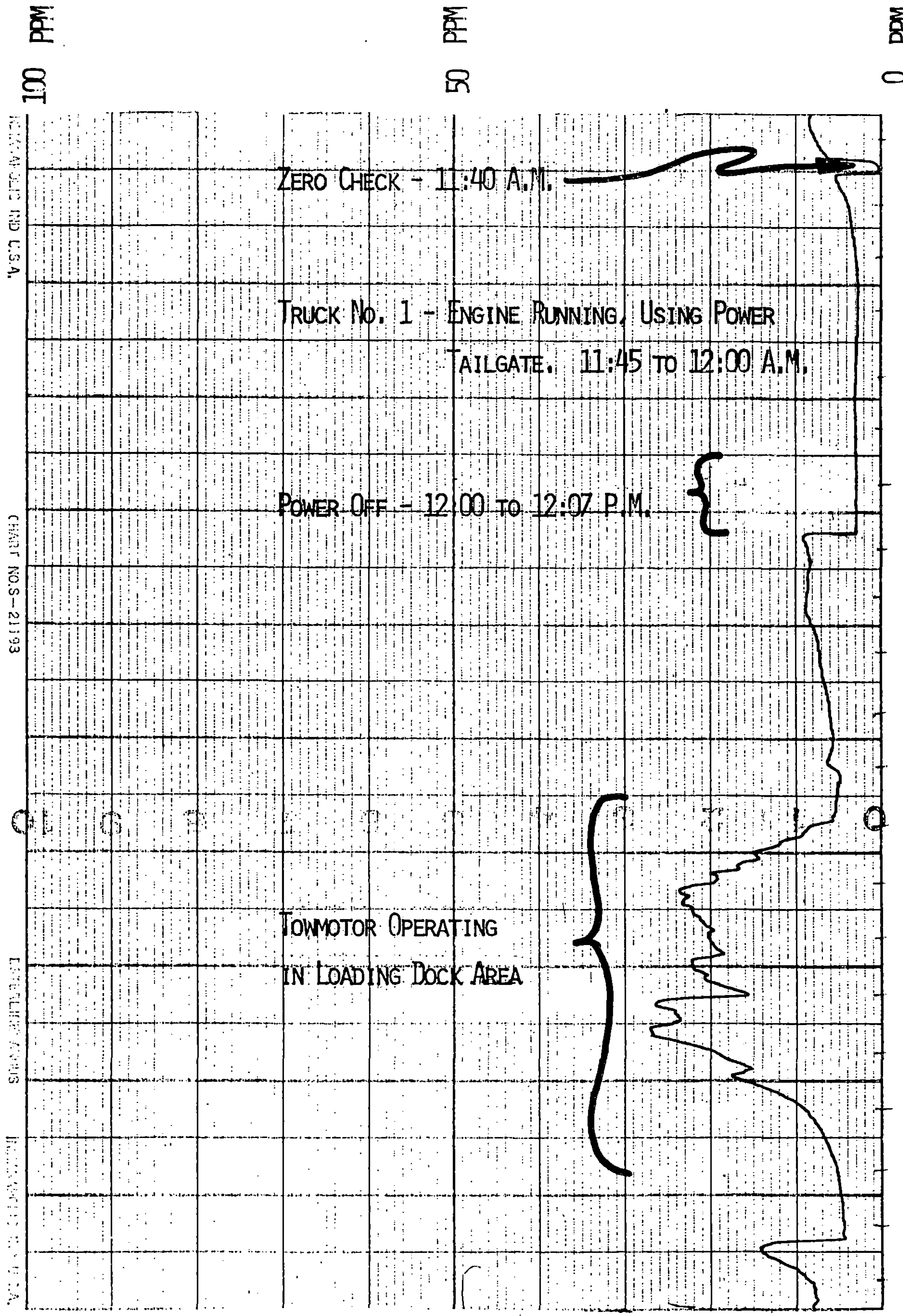
Blood saturation, % CO hemoglobin	Symptoms
0-10	No symptoms
10-20	Tightness across forehead; possibly slight headache, dilation of cutaneous blood vessels
20-30	Headache and throbbing in temples
30-40	Severe headache, weakness, dizziness, dimness of vision, vomiting, and collapse
40-50	Same as previous item with more possibility of collapse and syncope, and increased respiration and pulse
50-60	Syncope, increased respiration and pulse, coma with intermittent convulsions, and Chenye-Stokes respiration
60-70	Coma with intermittent convulsions, depressed heart action and respiration, and possibly death
70-80	Weak pulse and slow respiration, respiratory failure, and death

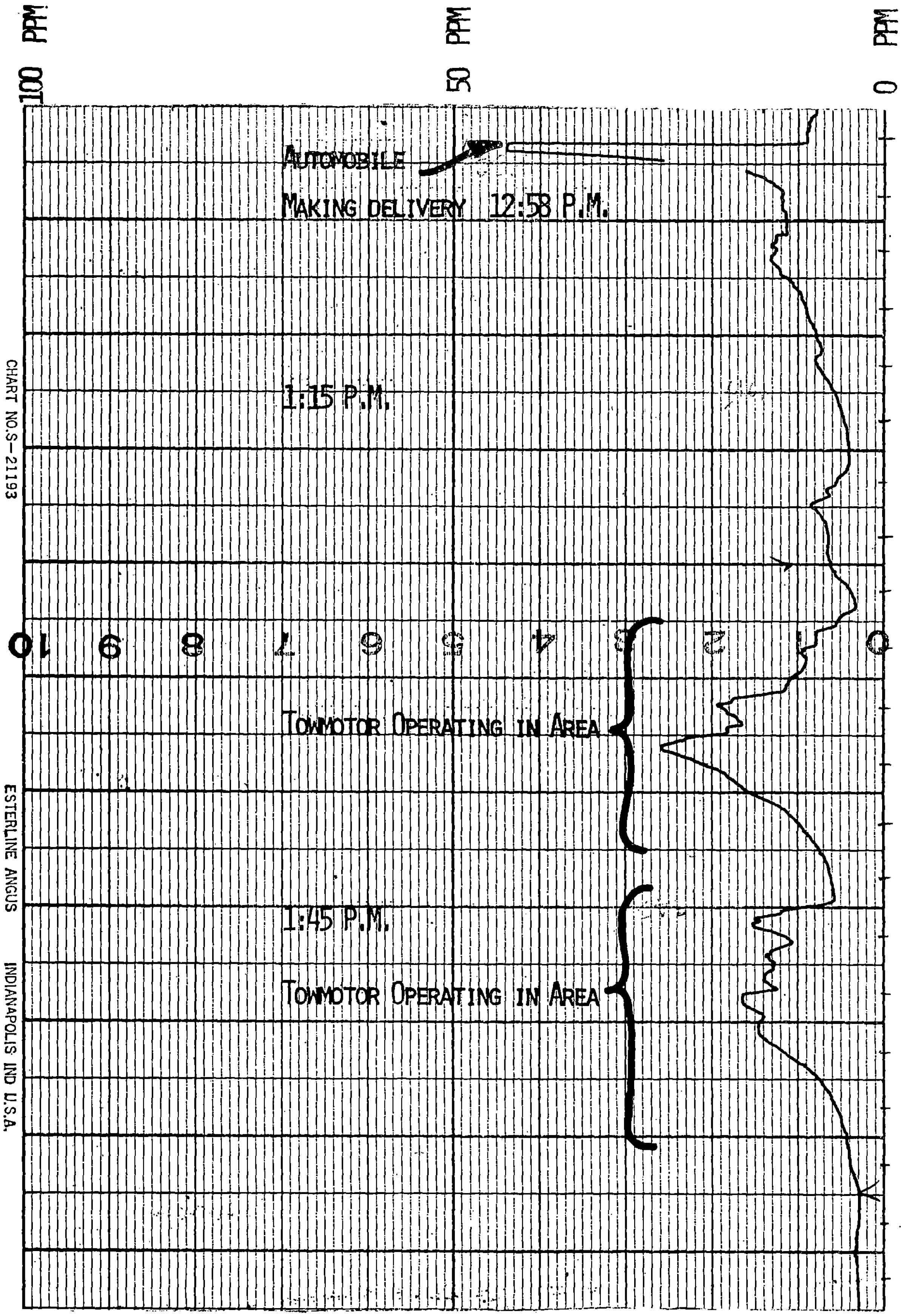
VIII. Appendix A: Carbon Monoxide Monitoring Data

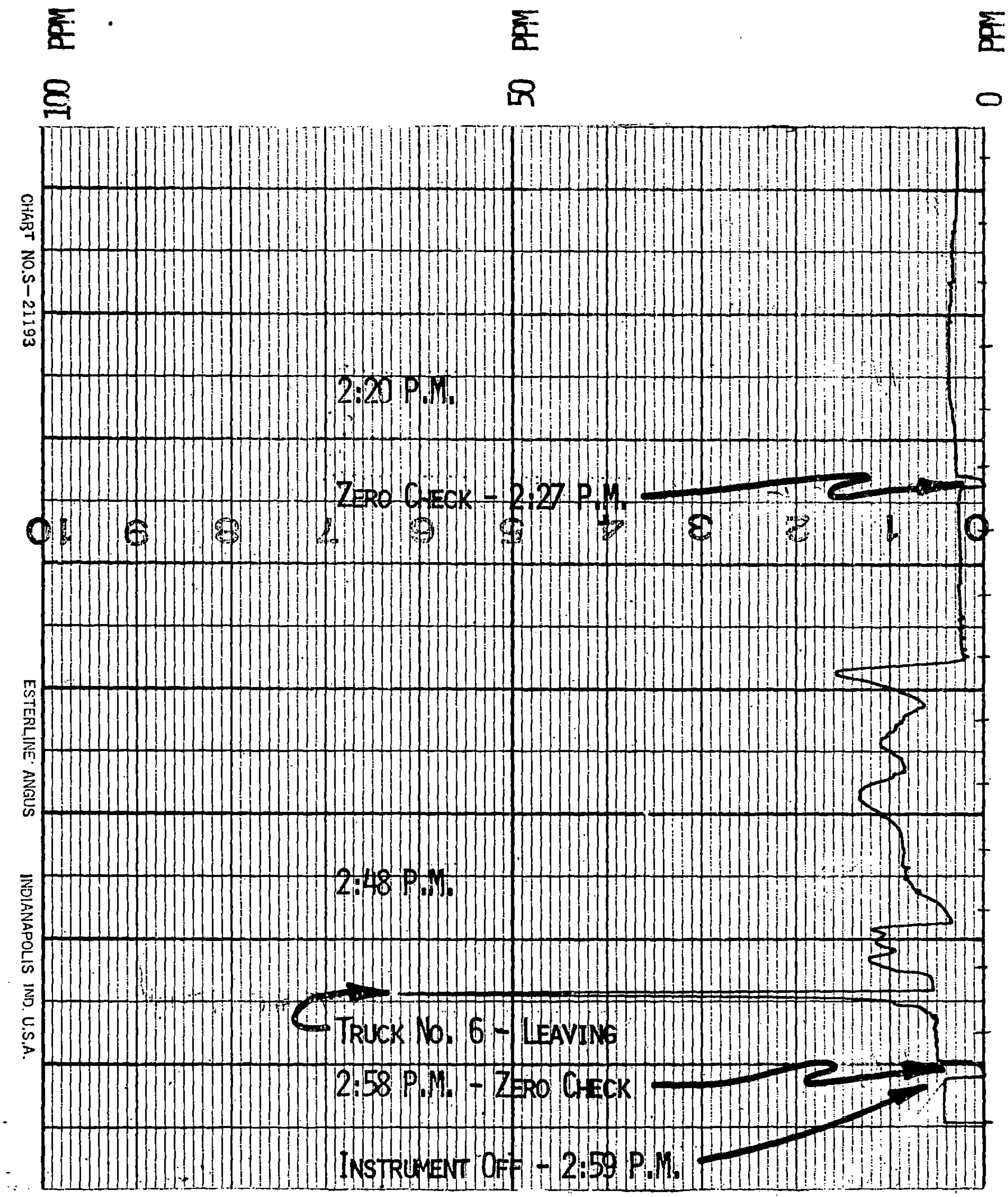



100 PPM
50 PPM
0 PPM
ARRIVAL OF TRUCK NO. 1
EXHAUST SYSTEM ATTACHED TO DELIVERY TRUCK NO. 1 - ENGINE RUNNING, POWER TAILGATE BEING USED.
EMPLOYEE SMOKING NEAR INSTRUMENT
ROLLUP DOOR BRIEFLY OPENED AND CLOSED - 10:10 A.M.
ROLLUP DOOR OPENED TO PERMIT ENTRY OF TRUCK NO. 2 - 10:24 A.M.


100 PPM
50 PPM
0 PPM
TOWMOTOR IN AREA BRIEFLY - 10:33 A.M.
TOWMOTOR ENTERED LOADING DOCK AREA
10:50 A.M.
ROLLUP DOOR OPENED
11:30 A.M.
TOWMOTER LEFT AREA, LUNCH PERIOD
STARTED FOR MANY EMPLOYEES
CHART NO S-21163


100 PPM
50 PPM
0 PPM
ZERO CHECK - 11:40 A.M.
TRUCK NO. 1 - ENGINE RUNNING, USING POWER TAILGATE. 11:45 TO 12:00 A.M.
POWER OFF - 12:00 TO 12:07 P.M.
TOWMOTOR OPERATING IN LOADING DOCK AREA
CHART NO.S-2193


100 PPM
50 PPM
0 PPM
AUTOMOBILE
MAKING DELIVERY 12:58 P.M.
1:15 P.M.
TOWMOTOR OPERATING IN AREA
1:45 P.M.
TOWMOTOR OPERATING IN AREA
CHART NO.S-21193
ESTERLINE ANGUS
INDIANAPOLIS IND U.S.A.


100 PPM
50 PPM
0 PPM
2:20 P.M.
ZERO CHECK - 2:27 P.M.
2:48 P.M.
TRUCK NO. 6 - LEAVING
2:58 P.M. - ZERO CHECK
INSTRUMENT OFF - 2:59 P.M.
CHART NO.S-21193
ESTERLINE ANGUS
INDIANAPOLIS IND. U.S.A.

APPENDIX B

Log Of Activity In Loading Dock Area

8:00 A.M.	Sampling equipment set up on platform of loading dock. Calibration procedure started.
8:24 A.M.	Carbon Monoxide monitoring started.
8:40 A.M.- 9:10 A.M.	Power interrupted; sampling instrument upset.
9:10 A.M.	Instrument stabilized; monitoring continued.
9:30 A.M.	Truck No. 1 arrived. (Diesel powered truck delivered bottled gases). Exhaust hood applied to exhaust pipe of truck within three minutes. Power tailgate operating with truck engine running.
9:55 A.M.	Truck No. 1 turned off engine. Driver started to move gas bottles to elevator.
10:05 A.M.	Roll-up door opened to allow Truck No. 2 to enter dock area. (Diesel powered semi; engine shut off immediately after parking ahead of Truck No. 1).
10:26 A.M.	Roll-up door closed
10:32 A.M.	Towmotor entered area to move materials being unloaded from Truck No. 2.
10:34 A.M.	Towmotor left dock area.
10:44 A.M.	Towmotor returned to dock area.
10:56 A.M.	Roll-up door opened.
10:57 A.M.	Roll-up door closed.
11:00 A.M.	Roll-up door opened.
11:01 A.M.	Roll-up door closed.
11:06 A.M.	Towmotor exhaust blowing directly at CO instrument.

11:17 A.M.	Roll-up door quickly opened and closed.
11:27 A.M.	Roll-up door opened and Truck No. 2 departed.
11:28 A.M.	Small delivery van Truck No. 3 entered dock area. Its gasoline engine was shut off immediately.
11:30 A.M.	Towmotor left dock area. Lunch break started for some employees.
11:34 A.M.	Roll-up door opened and Truck No. 3 departed.
11:35 A.M.	Roll-up door closed after Truck No. 4 backed in. (Large gasoline powered delivery truck). Truck engine shut off immediately.
11:40 A.M.	Instrument zero check.
11:45 A.M.	Truck No. 1 restarted engine.
12:00 Noon	Truck No. 1 - loading process complete.
12:01 P.M.	Portable exhaust disengaged from Truck No. 1. Engine shut off.
12:05 P.M.	Roll-up door opened; Truck Nos. 1 & 4 departed. Roll-up door closed. Power for monitoring instruments off.
12:10 P.M.	Power back on.
12:23 P.M.	NIOSH personnel started lunch break.
1:00 P.M.	NIOSH personnel returned to sampling station. During the lunch break the Towmotor operated in the dock area and an automobile made a delivery.
1:15 P.M.	Forklift operating intermittently in the dock area.
1:45 P.M.	Forklift operating extensively in dock area.
1:50 P.M.	Forklift stopped.
2:00 P.M.	Roll-up door opened and closed twice.
2:27 P.M.	Instrument zero check.
2:35 P.M.	Roll-up door opened. Truck No. 5 arrived. (Large gasoline powered truck). Engine shut off immediately. Roll-up door closed.
2:48 P.M.	Roll-up door opened.

2:51 P.M.	Truck No.5 departed.
2:52 P.M.	Truck No. 6 arrived. (Large gasoline powered delivery truck). Engine stopped immediately. Door closed.
2:54 P.M.	Roll-up door opened; Truck No. 6 departed.
2:55 P.M.	Door closed.
2:58 P.M.	Instrument zero check. Instrument off.