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EMPIRE DISTRIBUTORS, INC
ATLANTA, GEORGIA

NIOSH INVESTIGATOR:
Max Kiefer, CIH

SUMMARY

On April 28, 1992, the National Institute for Occupational Safety and Health (NIOSH), Atlanta Regional Office, received a confidential request to conduct a health hazard evaluation (HHE) at Empire Distributors, Inc., a wholesale beverage distribution warehouse in Atlanta, GA. The request asked NIOSH to determine if exposure to diesel exhaust emissions from company delivery trucks present a health hazard to employees. The request indicated employees have experienced health symptoms such as runny nose, cough, watery eyes and headaches they attributed to diesel emissions.

On June 2, 1992, NIOSH conducted an initial site visit at the warehouse. The purpose of this visit was to inspect the facility, conduct limited environmental sampling, assess diesel truck operating procedures, and develop a more extensive environmental sampling strategy. On July 14-15, 1992, environmental sampling was conducted to assess employee exposure to elemental carbon (C_e). Although there is no established method for measuring overall exposure to diesel exhaust, NIOSH is assessing the use of C_e as an index of diesel emission concentrations. Full-shift personal breathing zone (PBZ) samples were collected from 3 truck drivers, the check-out clerk, a fork-truck operator, and 3 employees in order preparation (Split Line). Area samples were collected in the Shipping Office, the Check-out station, and behind the A/B and Split Lines. A "background" ambient air sample was also obtained outside the facility in a nearby rural location. Sampling was conducted during truck start-up activities (6AM-7AM) on 7/14/92, and the evening truck-loading operation on 7/15/92.

An electronic particle counter was used to continuously count and log particles less than 1 micrometer in diameter (1µmd) during the start-up activities and at the split-line (95% of diesel particulate is < 1µmd). The counter was used to assess the utility of this monitor for determining the relative impact of truck traffic on particle levels, as well as clearance times during periods of no truck traffic. Sampling was also conducted in various areas to assess instantaneous levels of nitrogen dioxide (NO_2) and 4-hour integrated concentrations of carbon monoxide (CO).

The highest concentrations of C_e were detected on the truck drivers (5.5 - 17 micrograms per cubic meter [$\mu g/m^3$]) and the check-out operator (7.1 $\mu g/m^3$). These employees have more direct contact with the diesel trucks than other warehouse workers. Although these results are not comparable with any existing exposure criteria, the data does provide information for comparison purposes, as well as providing a baseline for assessing the effectiveness of controls.

The results of the particle monitoring show that particle counts were much higher (about 3X) during the morning truck start-up activities than during the evening Split Line work. Also, particle levels remained elevated for over an hour after the last truck left the warehouse in the morning, and then slowly decreased in concentration. Cigarette smoking, however, which takes place throughout the warehouse, was a confounding factor on the particle counts.

The highest NO_2 levels were seen during the morning truck start-up activities. Levels of 0.5 ppm were found at the truck Check-out line and in the full-case area at the back of the warehouse. NO_2 was not detected during the evening sampling. The NIOSH Recommended Exposure Limit (REL) for NO_2 is 1 part per million (ppm) as a 15-minute short-term exposure limit. The highest level of CO detected was 3 ppm at the full-case area in the back of the warehouse. The NIOSH REL for CO is 35 ppm as a full-shift time-weighted average. As with the NO_2, the levels were higher during the morning truck start-up activities.

Informal interviews conducted with truck drivers and warehouse employees found workers were periodically experiencing eye or throat irritation they attributed to diesel exhaust emissions.

Workers indicated these symptoms are more prevalent in the winter when circulation fans are off and doors are kept closed. Workers also stated that the ongoing conversion from older to newer trucks has visibly reduced emission levels and the extent of irritation, for both warehouse workers and truck drivers.

Research on diesel exhaust exposure has shown that eye irritation and reversible pulmonary function changes have been experienced by exposed workers. Additionally, based on findings of carcinogenic responses in exposed rats and mice, NIOSH recommends that whole diesel exhaust be considered a potential occupational carcinogen, and that exposures be reduced to the lowest feasible concentration (LFC).

Employees have experienced transient eye and throat irritation that is possibly associated with diesel exhaust emissions. The potential exists for elevated levels of NO_2 during the morning start-up activities, most likely during the winter months. Because of the transient irritation experienced by employees, the potential for elevated NO_2 levels, and the "potential occupational carcinogen" designation for diesel exhaust emissions, efforts to reduce exposure to diesel emissions should be implemented. Suggestions for controlling exposures are offered in the Recommendation section of this report.

KEYWORDS: SIC 4215 (Trucking and Courier Services, Except by Air) diesel exhaust exposures, nitrogen dioxide, carbon monoxide, elemental carbon, particulates, eye and throat irritation, headache

INTRODUCTION

NIOSH received a request from the Amalgamated Clothing and Textile Workers Union (ACTWU) on April 28, 1992, to investigate worker exposures to diesel exhaust at the Empire Distributors, Inc., warehouse in Atlanta, Georgia. ACTWU represents employees at this warehouse. Reported health problems included runny nose, cough, watery eyes, and headaches.

On June 2, 1992, NIOSH conducted an initial site visit to inspect the facility, assess operating practices, and develop a sampling strategy. NIOSH conducted a second site visit on July 14-15, 1992, to collect personal and area air samples for various diesel exhaust emission components. Informal interviews were conducted with truck drivers and warehouse employees.

An initial response letter describing preliminary findings and recommendations, and future actions was issued to Empire Distributors management and union representatives on August 10, 1992.

BACKGROUND

Facility Description

Empire Distributors is a wholesale beverage distributor serving Metro Atlanta and outlying areas. The 195,000 square foot facility was occupied in 1972 and consists of three joined warehouses and administrative offices (Figure 1). The company employs approximately 40 warehouse workers and 33 truck drivers. Work-shifts are as follows:

Truck Drivers	7:00 AM - Completed Delivery
Day Shift	8:00 AM - 4:30 PM
Check-out Clerk	1:00 PM - 9:00 PM
Night Shift	6:00 PM - Completed Truck Loading (3-4 AM)

The company has 32 medium-size diesel engine delivery trucks. All but 7 trucks have been replaced with newer models, and older trucks are being phased out at a rate of 1 every 2 months. It was observed that the newer trucks emit much less visible emissions than the older models. All trucks use #2 diesel fuel and have under-carriage exhaust systems.

Process Description

Trucks are loaded during the night shift at the center warehouse. No more than 4 trucks are loaded at one time, and the vehicles are turned off during loading. The loading dock is in a covered area of the warehouse and is accessed through 6 large bay doors. After loading, the trucks are parked in front of the receiving and center warehouse docks. The bay doors are shut to secure the trucks.

Truck drivers begin arriving at 6:00 AM, receive their delivery orders, and are assigned a truck. The bay doors are opened prior to starting up the trucks. In general, all trucks have left the premises by 7:30 AM. Returning trucks are re-fueled by the driver at the facility and checked at the check-out station in the center warehouse. Trucks may return as early as 3 PM or as late as 11 PM.

The Split Line operation is adjacent the loading dock in the center warehouse and employs 8-12 workers. This line prepares custom orders and operates only during the evening shift. Full cases of beverages are stored in the A/B line.

The company has a policy that all trucks must be turned off when loading or unloading at the docks. All fork-lifts at the warehouse are electric. There is one propane-powered floor sweeper that operates approximately 4 hours/week. Smoking is permitted throughout the facility. During the day, delivery trucks may unload product at the receiving warehouse dock.

EVALUATION PROCEDURES

The NIOSH evaluation consisted of the following elements:

(1) A facility inspection to review employee work areas, truck start-up and loading locations, and existing ventilation systems. Company information regarding work-shifts and administrative procedures was also obtained.

(2) A literature search to review the health effects associated with exposure to diesel emissions, determine appropriate sampling methodologies, and review the results of other industrial hygiene investigations involving the assessment of exposure to diesel exhaust emissions.

(3) Environmental monitoring to assess airborne levels of the following constituents of diesel exhaust: elemental carbon (C_e), carbon monoxide (CO), nitrogen dioxide (NO_2), and particulates. Area and personal sampling was conducted during the morning truck start-up activities and the evening Split Line operation.

Specific sampling and analytical methods used during this project were as follows:

A. Elemental Carbon (C_e)

Integrated air samples for C_e were collected using calibrated Gilian HFS 513A sampling pumps. Nominal flow rates of 2 liters per minute (Lpm) were used to collect the samples. Pre-fired 37 millimeter quartz fiber filters were used as the collection media. Stainless steel backup pads in 3-piece polystyrene cassettes were used to hold the filters. The cassettes were connected to the pumps with Tygon® tubing. As only a portion of the filter is analyzed, samples were collected in the open-face mode to help ensure a more even distribution across the filter. Personal sampling was conducted by attaching the pumps to selected workers and placing the sampling media in the employees' breathing zone. Employees were cautioned not to touch the sampling media. Sampling was conducted throughout the work shift. After sampling, the pumps were post-calibrated and the filters placed aluminum foil-lined petri dishes and shipped to the laboratory (Sunset Laboratory, Forest Grove, OR) for analysis. Field blanks were submitted with the samples and all results were blank corrected.

The filters were analyzed by a method known as thermal-optical analysis. With this technique, using various temperatures and furnace atmospheres, organic and elemental carbon is differentiated and driven off of the filter in stages. The released carbon is first oxidized to carbon dioxide (CO_2), reduced to methane (CH_4), and subsequently quantified with a flame-ionization detector.

B. Carbon Monoxide and Nitrogen Dioxide

On June 2, instantaneous area samples for CO were collected with a direct-reading monitor (Industrial Scientific CO260) that was calibrated with a known concentration of CO prior to use. The limit of detection for this monitor is 1 ppm. Integrated area samples for CO were collected on July 14-15 using direct-reading long-term colorimetric detector tubes manufactured by Dräger (67 28741). These tubes contain a chemically impregnated media which will change color in proportion to the concentration of CO. The samples were collected using constant-volume SKC model 223 low-flow sampling pumps. Flow rates of 15-20 cubic-centimeters per minute (cc/min) were used to collect the samples. Sampling times ranged from 3 to 4 hours. Pump calibration was checked prior to sampling using the soap bubble/buret technique. The pumps are equipped with a pump stroke counter and the number of strokes necessary to pull a known volume of air was determined. This information was used to calculate an air volume per pump stroke "K" factor. The pump stroke count was recorded before and after sampling and the difference used to calculate the total volume of air sampled. According to Dräger, the relative standard deviation for this particular sampling method is 10-15%.[1]

Sampling for nitrogen dioxide (NO_2) was conducted on July 14-15, 1992 using direct-reading colorimetric indicator tubes (Dräger NO_2 tube 0.5/c CH30001) and a hand operated bellows pump. The manufacturer lists the relative standard deviation for this method as 10-15%.[1]

C. Particle Monitoring

Because a major portion of diesel emissions are particulate, a particle counter was used to assess the impact of truck traffic on overall particle levels, and determine clearance times during periods of no truck traffic. The results could also provide baseline information for evaluating the effectiveness of future control measures. The monitor can differentiate particles less than 1 µmd from larger ones; however, particles generated from other sources (e.g., tobacco smoke) are not distinguished from those due to diesel emissions.

Particle monitoring was conducted with a Met One, Inc. Model 227B hand held laser particle counter. This unit counts particles greater than 0.3 µmd and differentiates these from particles greater than 1 µmd. The unit was set to continuously monitor particles on a 1 minute cycle time. A primary standard was used to determine the monitor's flow rate and concentrations of particles between 0.3 µmd and 1 µmd in millions of particles per cubic foot of air (mppcf) were calculated.

EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by work place exposures, NIOSH field staff use established environmental criteria for the assessment of a number of chemical and physical agents. These criteria suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It should be noted, however, that not all workers will be protected from adverse health effects if their exposures are below the applicable limit. A small percentage may experience adverse health effects due to individual susceptibility, pre-existing medical conditions, and/or hypersensitivity (allergy).

Some hazardous substances or physical agents may act in combination with other work place exposures or the general environment to produce health effects even if occupational exposures are controlled at the applicable limit. Due to recognition of these factors, and as new information on toxic effects of an agent becomes available, evaluation criteria may change.

The primary sources of environmental evaluation criteria for the work place are: (1) NIOSH Criteria Documents and recommendations, (2) the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs), and (3) the U.S. Department of Labor Occupational Safety and Health Administration (OSHA) standards.[2-4] Often, NIOSH recommendations and ACGIH TLVs may be different than the corresponding OSHA standard. Both NIOSH recommendations and ACGIH TLVs are usually based on more recent information than OSHA standards due to the lengthy process involved with promulgating federal regulations. OSHA standards also may be required to consider the feasibility of controlling exposures in various industries where the hazardous agents are found; the NIOSH recommended exposure limits (RELs), by contrast, are based primarily on concerns relating to the prevention of occupational disease.

Whole Diesel Exhaust

Based on findings of carcinogenic responses in exposed rats and mice, NIOSH recommends that whole diesel exhaust be considered a potential occupational carcinogen and that exposures be reduced to the lowest feasible concentration (LFC).[5] In addition to the carcinogenic effects, eye irritation and reversible pulmonary function changes have been experienced by workers exposed to diesel exhaust.[(5-8)]

Diesel exhaust is a complex mixture that consists of both a gaseous and particulate fraction. The composition will vary greatly with fuel and engine type, maintenance, tuning, and exhaust gas treatment.[(5,9)] The gaseous constituents include carbon dioxide, carbon monoxide, nitrogen dioxide, oxides of sulfur and hydrocarbons. The particulate fraction (soot) of diesel exhaust is comprised of solid carbon cores produced during the combustion process. More than 95% of these particles are less than 1 µmd in size. It has been estimated that up to 18,000 different substances from the combustion process can be adsorbed onto diesel exhaust particulate.[5] Up to 65% of the total particulate mass may be these adsorbed substances and includes compounds such as polynuclear aromatic hydrocarbons (PAHs), some of which are carcinogenic.[5] Particles in this size range are considered respirable because when inhaled they reach the deeper, non-ciliated portions of the lungs where they may be retained. In general, particles greater than 7-10 µmd are all removed in the nasal passages and have little probability of penetrating to the lung. Particles smaller than this can reach the air-exchange regions (alveoli, respiratory bronchiole) of the lung, and are considered more hazardous.

As noted, based on the results of laboratory animal and human epidemiology studies, NIOSH considers whole diesel exhaust to be a potential occupational carcinogen.[5] The studies of rats and mice exposed to diesel emissions, especially the particulate portion, confirmed an association with lung tumors.[5] Human epidemiology studies also suggest an association between occupational exposure to whole diesel exhaust and lung cancer.[(5,10)]

In addition to the carcinogenic potential, many other components of diesel exhaust have known toxic effects. These effects include pulmonary irritation from NO_2, eye and mucous membrane irritation from sulfur dioxide and aldehyde compounds, and chemical asphyxiation effects from CO. Exposure criteria has been established for some of these compounds; however, there are no exposure limits directly applicable to evaluation of whole diesel exhaust emissions.

Assessing worker exposure to diesel exhaust is difficult because of the complex makeup of emissions, uncertainty about which specific agent(s) may be responsible for the carcinogenic properties, and the effect of other potential sources of similar compounds (e.g., tobacco smoke particles are also primarily < 1 µmd). Measurements of some commonly found components of diesel exhaust have generally shown concentrations to be well below established exposure criteria. Efforts have focused on evaluating the particulate portion because most studies have associated the carcinogenic potential of diesel exhaust with the particulate fraction. NIOSH is currently investigating the use of elemental carbon (C_e) as a surrogate index of exposure. The use of C_e holds promise because the sampling and analytical method is very sensitive, and a high percentage of diesel particulate (80-90%) is elemental carbon, whereas tobacco smoke particulate is composed primarily of organic carbon.[11] Although exposure criteria has not been established, sampling was conducted for C_e to determine the relative diesel emission levels in different areas, and to provide baseline information that could be useful for assessing the effectiveness of future control measures.

Nitrogen Dioxide

Sampling was conducted for NO_2 because it is commonly associated with diesel emissions, and because of its acute irritant effects. NO_2 is a reddish/dark-brown gas with a pungent, acrid odor. NO_2 is a respiratory irritant and can cause pulmonary edema.[12] The NIOSH REL for NO_2 is 1 ppm as a 15 minute short-term exposure limit (STEL).[2] Most reported cases of severe illness due to NO_2 have been from accidental exposures to explosion or combustion of nitroexplosives, nitric acid, arc or gas welding (particularly in confined spaces), or entry into unvented agricultural silos.[13]

Carbon Monoxide

CO is also associated with diesel exhaust and is of concern due to the insidious nature of this substance. CO is a colorless, odorless gas that is a product of incomplete combustion. Engine exhaust, tobacco smoking, and inadequately ventilated combustion products from heaters that use hydrocarbon fuel are sources of CO. Overexposure to CO may cause initial symptoms such as headache, dizziness, drowsiness, and nausea. These symptoms may progress to vomiting, loss of consciousness, or collapse if high exposures are encountered.[14] The NIOSH REL for CO is 35 ppm as a time-weighted average for up to 10 hours per day. NIOSH also recommends a ceiling level of 200 ppm for CO.[2]

Particulates

Regulatory standards for respirable particulates exist for many specific dusts (e.g., silica) and for a more general category termed "particulates not otherwise regulated." Dusts considered to be physical irritants for which no substance-specific toxicological data are available are generally placed in this category by OSHA for enforcement purposes.[15] The OSHA limit for respirable particulates not otherwise regulated, sometimes referred to as "inert" or "nuisance" dust, is 5 milligrams per cubic meter (mg/m^3). NIOSH has not adopted an REL for particulates not otherwise regulated. Note that exposure standards for particulates are based on mass per volume of air (e.g., mg/m^3) and not mppcf, which was the measured parameter. Although conversion formulas to determine mass/volume concentrations from mppcf data have been developed, assumptions regarding particle density and median diameter are necessary. Size distributions of particles present in diesel exhaust vary with engine type and operating conditions. Some estimates indicate that average diesel particle diameters may be less than 0.3 µm, which was the smallest size particle detectable with the monitor used.[16] Additionally, the regulatory standards for respirable nuisance, or otherwise unclassified dust are not comparable to diesel exhaust particulate. Therefore, the particle data should only be interpreted from the standpoint of assessing relative concentrations and clearance times, and should not be used for comparison with exposure criteria.

RESULTS AND DISCUSSION

Facility Inspection

Worker exposure to diesel emissions is considered to be worse in the center warehouse as this is where most truck activity takes place (adjoining warehouses are used for receiving and storage) and where the majority of employees work. Emission levels are also perceived to be higher during the winter as doors are usually kept closed and wall exhaust fans may be shut off. Truck start-up activities, the vehicle check-in station, and the Split Line operation were identified as the areas of primary concern.

Wall-mounted axial fans have been installed in the back of each warehouse and exhaust air directly outside. These fans operate most of the year but may be turned off in the winter. Axial fans have also been installed between the Center warehouse and the Receiving warehouse (air flow direction is from the Center to the Receiving warehouse). There is no air-conditioning except for an 8000 ft^2 section used for keeping beverages cool. Heating is provided by gas-fired heaters with flue gas vents ducted through the roof. One heater flue-gas duct in the Receiving/Storage warehouse was not connected to the heater. Comfort fans are located in various areas. There are doors in the back of the warehouse; however, according to management, these are rarely opened.

Subjective evaluation of air currents, conducted by generating smoke at the center warehouse loading dock, indicated primarily stagnant conditions with a slight trend into the warehouse. The tests were conducted with the axial fans at the back of the warehouse operational and all six warehouse bay doors open. Outside conditions were sunny with a light breeze.

Informal interviews with truck drivers and Split Line employees indicated that periodic eye and throat irritation has been experienced. The employees interviewed associate this transient irritation with diesel exhaust emissions. All employees interviewed stated that conditions during the winter months are subjectively worse, and that the old-style trucks created significantly more emissions than the newer model.

Environmental Monitoring

<u>Elemental (C_e) and Organic Carbon</u>

The results of C_e monitoring are shown in Table 1 (July 14) and Table 1A (July 15). The organic carbon fraction (not specific to diesel emissions) is determined during analysis and is also shown in these tables. The highest levels of C_e detected (17 micrograms/cubic meter [$\mu g/m^3$] and 8.1 $\mu g/m^3$) were found on personal samples obtained from two of the truck drivers monitored on July 14. A C_e concentration of 1.2 $\mu g/m^3$ was detected on the background sample obtained in a nearby rural area. Area C_e samples obtained on July 14 averaged 2.5 $\mu g/m^3$, while those taken on July 15 averaged 2.0 $\mu g/m^3$. The highest organic carbon levels were obtained inside the warehouse office on July 14 (121.0 $\mu g/m^3$) and July 15 (81.3 $\mu g/m^3$). Area organic carbon samples outside the warehouse office averaged 23.9 $\mu g/m^3$ on July 14 and 13.9 $\mu g/m^3$ on July 15. The relatively higher levels in the warehouse office may possibly be attributable to cigarette smoking which occurs in this enclosed office. As previously noted, these results are not comparable with any existing exposure criteria. However, the data does provide information for comparison purposes, as well as providing a baseline for assessing the effectiveness of controls.

<u>Carbon Monoxide/Nitrogen Dioxide</u>

The results of the CO and NO_2 air sampling are depicted in Table 2. Carbon monoxide levels were well below the NIOSH REL on all days sampled. The highest level detected was 3 ppm behind the A/B line on the morning of July 14, 1992.

As with the CO monitoring, the highest concentrations of NO_2 were detected on the morning of July 14, 1992. Instantaneous levels of 0.5 ppm were detected behind the A/B line and at the front of the Split Line. Although the NO_2 levels were below the NIOSH REL of 1 ppm (15 minute STEL), concentrations may be higher during the winter months when ventilation fans are off and doors are kept closed. Additional warm-up times for trucks, as well as maintenance and engine tuning could also impact NO_2 levels.

Particulates

The results of the particle monitoring are displayed in Figures 2 and 3. On July 14, 1992, the monitor was operated from 6:11 AM - 8:41 AM at the Check-out Station in the middle of the center loading dock. There were 17 trucks in the center warehouse area, and all bay doors were open. The first truck started up at 6:40 AM and the last truck had left the facility by 7:18 AM. The average particle count was 4.58 mppcf during this time (maximum = 6.33, minimum = 3.64). Several spikes (short-term increases in particles) were noted during the truck start-up time. However, counts averaged approximately 4.5 mppcf before the first truck started up, and did not begin to taper off to less than 4 mppcf until after 8:30 AM. Cigarette smoking took place throughout the area and may have been a confounding factor (possibly explaining the relatively elevated levels prior to the trucks starting up).

On July 15, 1992, the monitor was operated from 5:00 PM - 12:00 AM at the front of the Split Line operation, near the supervisor's desk. The average concentration from 8:14 to 11:14 PM was 1.24 mppcf (maximum = 4.20, minimum = 0.74). During this time the Split line was in operation (the line shut-down at 12:00 PM) and trucks were being loaded (no more than four trucks at a time at the dock, all trucks were shut-off after parking at the dock). As depicted in Figure 3, several spikes indicating short-term elevated levels of particles were noted during this time. However, the spikes do not appear to correlate with truck traffic, as no spikes were noted after 9:40 PM, although trucks were still being loaded. One possibility is cigarette smoking as the particle counter was located near a break area for employees.

CONCLUSIONS

Employees have experienced transient eye and throat irritation that is possibly associated with diesel exhaust emissions. The highest C_e concentrations detected were from the truck drivers and Check-out operator. This may be due to the relative constant contact these workers have with the diesel trucks. Other workers (e.g., split line operators, fork truck drivers) only intermittently come into contact with operating trucks (when moving to or from the loading dock). The potential exists for elevated levels of NO_2 during the AM start-up activities, most likely during the winter months. NO_2 was not detected during the night-shift monitoring. Carbon monoxide levels were well below established exposure criteria. The particle monitoring indicates relative particle concentrations during the morning truck start-up activities to be approximately 3 times higher than concentrations during the night-shift. Particle monitoring does appear to be useful for assessing the impact of diesel exhaust on overall particle levels. However, cigarette smoking or other dust-generating activities could be a confounding factor. Because of the transient irritation experienced by employees, the potential for elevated NO_2 levels, and the NIOSH occupational carcinogen designation for diesel exhaust emissions, efforts to reduce exposure to diesel emissions should be implemented.

RECOMMENDATIONS

1. The axial fans in the back of the facility appear to draw emissions from the dock into the warehouse. Options that should be investigated include the possibility of reversing the fans during the truck start-up activity, and/or installing additional fans in the covered area above the center and receiving dock parking area.

2. Investigate alternative (non-enclosed) parking areas for loaded trucks.

3. Continue to phase out the older trucks and replace with the newer models. Ensure maintenance and tune-up schedules are adhered to. Consult with the truck manufacturer regarding options and strategies that could be implemented to reduce diesel exhaust emissions.

4. Prevent involuntary worker exposure to tobacco smoke. NIOSH considers environmental tobacco smoke (ETS) to be a potential occupational carcinogen and recommends controlling exposures to the lowest feasible concentration.[11] The best method for controlling worker exposure to ETS is to eliminate smoking in the workplace. Until tobacco use can be eliminated, nonsmokers should be protected from ETS by providing isolated smoking areas.

5. During the survey it was noted that in an emergency employee evacuation could present a safety problem. There are no emergency exits at the back of the warehouse, and egress corridors are not defined, and are often blocked by conveyors or material. Clearly defined egress paths should be determined, and employees informed of the proper evacuation protocol in the event of an emergency (e.g., fire). Consider posting evacuation maps as a reminder to employees. Consult with local building code authorities to determine the appropriate number and location of emergency exits.

6. Repair the gas-fired heater duct in the receiving warehouse to ensure flue gas is properly ventilated out of the building.

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AUTHORSHIP AND ACKNOWLEDGMENTS

Evaluation Conducted and Report Prepared By:	Max Kiefer, CIH Regional Industrial Hygienist NIOSH Atlanta Regional Office
Field Assistance Provided By:	John Decker, MS, IHIT Regional Industrial Hygienist NIOSH Atlanta Regional office
Originating Office:	NIOSH Hazard Evaluations and Technical Assistance Branch

Division of Surveillance,
Hazard Evaluations, and
Field Studies
NIOSH
Cincinnati, Ohio

Laboratory Support — Staff
Measurements Research Support
Branch, NIOSH
Cincinnati, Ohio

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Table 1
Elemental and Organic Carbon Monitoring Results
Empire Distributors, Atlanta, GA
July 14, 1992
HETA 92-226

Sample ID	Task Monitored	Sample Time (min)	C_e µg/m³ TWA	OC µg/m³ TWA
A-1	Check-out Line (Area)	06:10 - 17:32 (682)	1.8	14.1
A-2	Warehouse Office (Area)	06:20 - 16:04 (622)	2.6	121.0
A-3	Behind A/B Line (Area)	06:22 - 17:01 (642)	3.6	22.4
A-4	Split Line (Area)	06:31 - 16:57 (631)	1.8	19.4
A-5	Background	07:40 - 17:49 (608)	1.2	9.8
P-1	Truck Driver (Personal)	06:54 - 10:31 (217)	17.0	40.1
P-2	Truck Driver (Personal)	07:01 - 16:20 (541)	5.5	36.6
P-3	Truck Driver (Personal)	07:00 - 12:36 (336)	8.1	25.0

Table 1A
Elemental and Organic Carbon Monitoring Results
Empire Distributors, Atlanta, GA
July 15, 1992
HETA 92-226

Sample ID	Task Monitored	Sample Time (min)	C_e µg/m³ TWA	OC µg/m³ TWA
SLP-1	Split Line Op. (Personal)	18:09 - 00:17 (370)	3.2	66.3
SLP-2	Split Line Op. (Personal)	18:11 - 00:32 (383)	4.3	48.9
SLP-3	Split Line Op. (Personal)	18:15 - 23:53 (338)	2.4	61.6
SLA-1	Split Line (Area)	16:43 - 00:28 (468)	2.3	13.5
A2-1	Warehouse Office (Area)	16:32 - 00:20 (468)	2.0	81.3
A2-2	Behind A/B Line (Area)	16:46 - 00:24 (460)	1.6	14.3
COP-1	Check Out Op. (Personal)	16:34 - 20:20 (227)	7.1	33.9
FL-1	Fork Lift Op. (Personal)	18:07 - 23:02 (295)	4.0	54.6

Notes: µg/m³ = micrograms of carbon per cubic meter of air sampled
C_e = elemental carbon
OC = organic carbon
TWA = time-weighted average concentration

All truck drivers sampled were operating the newer diesel truck.

Table 2
Area Monitoring Results: Empire Distributors, Atlanta, GA
June 2, July 14-15, 1992
HETA 92-226

Location	CO (ppm)	NO_2 (ppm)	Comments
[illegible]			
West Side Center Dock (2:30 PM)	ND	NM	Direct Reading Sample
Check-Out Line (2:45 PM)	ND	NM	Direct Reading Sample
A/B Line (Front, 3:00 PM)	ND	NM	Direct Reading Sample
Receiving Dock (3:15 PM)	ND	NM	Direct Reading Sample
A/B Line (Back, 3:30 PM)	ND	NM	Direct Reading Sample
[illegible]			
Behind HINO Truck (7:00 AM)	NM	ND	Direct Reading Sample
Check-out Line (7:05 AM)	NM	ND	Direct Reading Sample
Split Line (Front, 7:15 AM)	NM	0.5	Direct Reading Sample
Check-out Line (7:20 AM)	NM	Trace*	Direct Reading Sample
A/B Line (Back, 7:25 AM)	NM	0.5	Direct Reading Sample
Check-out Line (6:10-9:05 AM)	0.95	NM	Long-term Sample
A/B Line (Back, 6:22-9:08 AM)	3	NM	Long-term Sample
[illegible]			
Check-out Line (5:20 PM)	NM	ND	Direct Reading Sample
Split Line (8:10 PM)	NM	ND	Direct Reading Sample
Split Line (6:20-10:00 PM)	0.5	NM	Long-term Sample
A/B Line (Back, 6:25-10:10 PM)	0.5	NM	Long-term Sample

NOTE: ppm = parts of gas or vapor per million parts air
ND = None Detected, the detection limit for NO_2 is 0.5 ppm, the detection limit for CO is 1 ppm
NM = Contaminant not measured
Trace = slight, unquantifiable discoloration noted on the colorimetric detector tube.