HAZARD EVALUATION AND TECHNICAL ASSISTANCE REPORT
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IBM MID AMERICA EMPLOYEES FCU
KANSAS CITY, MISSOURI
MAY 1990

Hazard Evaluation and Technical Assistance Branch
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I. INTRODUCTION

On January 23, 1990, the National Institute for Occupational Safety and Health (NIOSH) received a request to evaluate exposures among workers in the IBM Mid America Employees Federal Credit Union (FCU), 2345 Grand, Kansas City, Missouri. The requestor was concerned with employee complaints of dizziness and nausea related to vehicle exhaust originating in the buildings loading dock. On March 13 & 14, 1990, an environmental survey was conducted by the NIOSH investigator during which the work area was inspected and air samples were collected.

II. BACKGROUND

The IBM Mid America Employees FCU is located on the ground floor of a multi-story office complex. Four to five employees work in the credit union for a period of eight and one-half hours each day. The credit union moved from the 27th floor of the complex into its present location approximately two years ago. Since that time, employees have complained of the smell of exhaust fumes and occasional symptoms including dizziness and nausea. Conditions were reportedly worst during cold weather, and particularly in the morning. A review of a log maintained by the credit union indicated that for the period between December 20, 1990 and March 7, 1990, there were 19 days on which the exhaust fumes were noticeable.

Ventilation to the credit union is supplied through a constant volume heating, ventilation, and air conditioning (HVAC) system. The air handling unit (AHU) is equipped with an enthalpy sensor which regulates the amount of outside air entering the system. Although no gauges were present which would indicate specific airflows on the AHU, based on the fresh air damper settings, it was estimated by building management that a minimum amount of 20% outside air was supplied to the system at all times. The ceiling of the credit union serves as a return air plenum for the HVAC system.

Located behind the rear wall of the credit union is the underground loading dock area which services the building. The loading dock consists of four loading bays. Connected to the loading dock are limited parking areas which can house approximately 50 automobiles. The underground loading dock and garage area is equipped with two exhaust fans rated at 25 and 35 thousand cubic feet per minute (cfm). An additional three thousand cfm exhaust fan is located above a trash compacting area next to the loading dock. Signs were present on the loading dock indicating that drivers should turn off engines when loading and unloading.

Based on conversation with loading dock staff, it was determined that the vast majority of trucks delivering to the dock area were diesel vehicles. In addition, it was estimated that 80% of the deliveries were made between the hours of 8:00 am and 12:00 pm. Automobile traffic in the area was noted to be very minimal during the period of the survey.

During the past winter, the building management had re-insulated the wall behind the credit union and sealed the cracks and seams on the wall with a insulating foam material.

III. MATERIALS AND METHODS

On March 13 & 14, 1990, the NIOSH investigator conducted an environmental survey at the building. The survey consisted of: (1) an examination of the credit union and loading dock areas and the related heating, ventilation, and air conditioning (HVAC) systems, (2) the collection of environmental samples for possible constituents of vehicle exhaust, and (3) the use of smoke generating tubes to determine airflow patterns between the dock and office areas.

In order to provide a better understanding of the sampling protocol used in this survey, the following overview of the components of diesel exhaust, the principle type of exhaust which would be expected to be present, is provided below.

Diesel exhaust is a very complex mixture, and its composition varies greatly with fuel and engine type, load cycle, maintenance, tuning, and exhaust gas treatment. The exhaust emissions from diesel engines are composed of both gaseous and particulate fractions. The gaseous components include oxides of sulfur, nitrogen dioxide, nitric oxide, carbon monoxide, carbon dioxide, and hydrocarbons (e.g., ethylene, formaldehyde, methane, benzene, phenol, 1,3-butadiene, acrolein, and polynuclear aromatic hydrocarbons). The particulate fraction (soot) is composed of solid carbon cores, produced during the combustion process, that tend to form aggregates, the largest of which are in the respirable range (more than 95% are less than 1 micron in size). It has been estimated that as many as 18,000 different substances from the combustion process can be absorbed onto diesel exhaust particulates. This absorbed material contains 15% to 65% of the total particulate mass and includes such compounds as polynuclear aromatic hydrocarbons (PAHs).[1]

While exhaust from gasoline vehicles is also composed of numerous constituents, carbon monoxide is one substance which is easily identifiable and of principle concern from a toxicological standpoint.

The NIOSH environmental survey focused on evaluating the gaseous components of the vehicle exhaust. This was due to the relative ease with which these substances can be measured, compared with the complexity of attempting to quantify diesel particulate at the relatively low concentrations which would be expected under these conditions. During the survey, air samples were collected for the various gases using the following Drager colorimetric indicator tubes: carbon monoxide (5/c), sulfur dioxide (0.5/a), nitrogen dioxide (2/c), and nitrous fumes

(0.5/a). These samples were collected at different intervals throughout the day. Measurements of carbon dioxide levels were also made periodically using a GasTech (Model RI 411) portable direct-reading CO_2 analyzer. The instrument was calibrated before use and checked against background levels at various intervals throughout the workday. In addition, battery-powered sampling pumps operating at 20 cubic centimeters of air per minute were used in conjunction with Drager long-term detector tubes (CO 50/a-1) to quantify carbon monoxide exposures over the course of the work-shift.

In addition to the collection of air samples, smoke tubes were used to determine airflow patterns between the loading dock area and the building offices. This was accomplished by visual observation of the direction of the movement of the smoke at different locations in the dock area.

IV. EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to 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 is important, however, to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a preexisting medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects often are not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes and, thus, potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent becomes available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs), 3) the U.S. Department of Labor/Occupational Safety and Health Administration (OSHA) occupational health standards [Permissible Exposure Limits (PELs)]. Often, the NIOSH recommendations and ACGIH TLVs are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLVs usually are based on more recent information than are the OSHA standards. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that the company is required by the Occupational Safety and Health Administration to meet those levels specified in an OSHA standard.

As previously discussed, diesel exhaust is a complex mixture of substances. Many of the individual components of diesel exhaust are known to have toxic effects. Among the major health effects associated with some components found in diesel exhaust, are: 1) pulmonary irritation from nitrogen dioxide, and 2) irritation of the mucous membranes and eyes from sulfur dioxide, phenol, sulfuric acid, sulfate aerosols, and acrolein. In addition, several recent animal studies in rats and mice, as well as limited epidemiological information of railroad workers with over 10 years of exposure to diesel exhaust, suggest an association between cancer and exposure to whole diesel exhaust. Based on these data, NIOSH recommends that because of its carcinogenic potential, exposure to diesel emissions be reduced to the lowest feasible limits.[1]

Table 1 contains the Permissible Exposure Limits promulgated by the Occupational Safety and Health Administration (OSHA PELs), the ACGIH TLVs, and the NIOSH Recommended Exposure Limits (NIOSH RELs) which are relevant to the specific substances for which air samples were collected in this evaluation.

V. RESULTS

The results of the detector tube samples collected at the different intervals throughout two day sampling period revealed concentrations of nitrogen dioxide, nitrous gas, and sulfur dioxide were below the limits of quantitation. The limits of quantitation for each of the substances were: carbon monoxide (5 ppm), sulfur dioxide (0.5 ppm), nitrogen dioxide (0.5 ppm), nitrous fumes (0.5 ppm). The concentrations of carbon dioxide that were measured (500 to 600 parts per million) are levels that would normally be expected to exist as background, given the occupancy of the building. Outdoor dry bulb temperatures averaged 70° F during the sampling period on March 13, and 58° F during the sampling period on March 14.

Visual observation of the direction of movement of the smoke generated by the smoke tubes did not indicate air to be flowing from the loading dock area into the credit union offices through the common wall area. However, the smoke did rapidly flow from the dock area through a corridor which entered the building hallway a short distance from the credit union. Although two sets of double doors were present in this corridor, the smoke readily traveled between the openings around the closed doors. It should be noted that air flow patterns between the office and dock areas could change with different environmental conditions, especially under more dramatic indoor/outdoor temperature differences.

During the inspection of the loading dock area, one instance was observed where all the loading dock bays were occupied and a waiting truck was idling at the entrance to the dock. During this episode, the odor of diesel exhaust in the dock area was much more noticeable than normal. No signs were noted to be present on the entrance ramp to remind drivers to turn off their engines while waiting for dock space.

VI. DISCUSSION AND CONCLUSIONS

As evidenced by the results of the environmental survey, the concentrations of the contaminants comprising the gaseous portion of the exhaust emissions were found to be at very low or non-detectable levels at the time of the survey. However, during the period of the survey the employees in the credit union did not report the presence of the odors that were normally associated with the vehicle exhaust. Therefore, these results may not be representative of the conditions which trigger the employee complaints.

Despite the lack of findings of contaminant levels from the diesel exhaust, it would still be prudent to reduce potential exposures to the exhaust as much as possible. The primary means of accomplishing this should be to ensure that the amount of exhaust generated in the dock area is kept to a minimum. Strictly enforcing current dock policies for shutting down vehicle engines as well as the addition of this policy to include vehicles waiting for dock space, should help to reduce the potential for any complaints related to the exhaust. In addition, minimizing the amount of airflow into the building spaces from the dock would further reduce the chances of complaints related to the exhaust.

VII. RECOMMENDATIONS

1. Loading dock supervisory personnel should ensure that the docks policy of shutting down engines during loading and unloading is strictly adhered to.

2. Signs should be posted at the entrance to the loading dock reminding drivers to shut down engines while waiting for loading dock space.

3. The hallway doors which connect the dock area to the building lobby should be weather-stripped or sealed more tightly so as to minimize the introduction of vehicle exhaust into the building spaces.

4. Further testing with smoke tubes and/or other environmental monitoring instrumentation should be conducted during periods when the exhaust odors are prevalent in the office areas. This may help to determine if exhaust gas seepage through the common wall is an important factor in the introduction of the gases into the credit union office.

VIII. REFERENCES

1. National Institute for Occupational Safety and Health. Current Intelligence Bulletin 50, Carcinogenic Effects of Exposure to Diesel Exhaust. DHHS (NIOSH) Publication No. 88-116. August 1988.

Table 1
Limits for Occupational Exposure to Selected Components of the Gaseous Fraction of Diesel Exhaust

COMPONENT	OSHA PEL	NIOSH REL	ACGIH TLV
Carbon Dioxide	10,000 ppm 8-hr TWA 30,000 ppm STEL	10,000 ppm 8-hr TWA 30,000 ceiling (10 min)	5,000 ppm 8-hr TWA 30,000 ppm STEL
Carbon Monoxide	35 ppm 8-hr TWA 200 ppm ceiling (no minimum time)	35 ppm 8-hr TWA 200 ppm ceiling (no minimum time)	50 ppm 8-hr TWA 400 ppm STEL
Nitric Oxide	25 ppm 8-hr TWA	25 ppm 8-hr TWA	25 ppm 8-hr TWA
Nitrogen Dioxide	1 ppm STEL	1 ppm ceiling (15 minutes)	3 ppm 8-hr TWA 5 ppm STEL
Sulfur Dioxide	2 ppm 8-hr TWA 5 ppm STEL	0.5 ppm 8-hr TWA	2 ppm 8-hr TWA 5 ppm STEL

Abbreviations and Key
TWA - Time-weighted average concentration
ppm - Parts of contaminant per million parts of air
STEL - Short-term exposure limit; 15-minute TWA exposure
LFL - Lowest Feasible Level