HEALTH HAZARD EVALUATION REPORT

HETA 93-884-2344
NATIONAL CENTERS FOR HEALTH ENVIRONMENT
ALBANY, NEW YORK

Preface

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer and authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to federal, state, and local agencies; labor; industry; and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

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I. Summary

In May 1993, the National Institute for Occupational Safety and Health **(NIOSH)** received a request for technical assistance from the Centers for Disease Control and Prevention **(CDC)**, National Center for Environmental Health **(NCEH)**. This request was made in conjunction with the CDC EPI-AID investigation **(EPI 93-61-1)** which was requested by the New York State Department of Health. Specifically, NIOSH was asked to evaluate workers' exposures to the gasoline components methyl *tert*-butyl ether **(MtBE)**, benzene, toluene, and xylene. Site visits were made to five facilities (one indoor parking garage, one medical taxi company, one automobile dealership/repair shop, one auto repair shop, and one state highway maintenance garage) from May 3-7, 1993.

Air monitoring was performed on mechanics, service advisors, and other workers potentially exposed to gasoline and exhaust emissions during their workday. Twenty-four personal breathing-zone samples were collected and analyzed for benzene, toluene, xylene, and MtBE.

Since this environmental sampling was conducted in warm weather, dilution ventilation (from open windows and service doors) may have played a significant role in reducing exposures and must be considered when assessing the results. Higher indoor workplace exposures to MtBE and benzene may occur during the winter when the effect from dilution ventilation is at a minimum.

Personal breathing-zone samples for toluene and xylene ranged from less than 0.03 to 0.73 parts per million **(ppm)**, and less than 0.02 to 0.43 ppm, respectively. These levels are well below the pertinent occupational health exposure criteria. MtBE exposure levels ranged from less than 0.03 to 0.14 ppm; levels well below the American Industrial Hygiene Association **(AIHA)** Workplace Environmental Exposure Limit **(WEEL)** of 100 ppm. The benzene concentrations ranged from less than 0.006 to 0.054 ppm. Although NIOSH has established this guideline which should not be exceeded, the Institute still urges that exposures be reduced to the "lowest feasible level."

The environmental data gathered during this investigation indicate that employees were **not** exposed to airborne concentrations of MtBE, toluene, xylene, or benzene in excess of their pertinent occupational standards. Recommendations to provide additional administrative and engineering controls to further reduce employee exposures to solvents, and for curtailing cigarette smoking in the workplace are provided in Section VIII of this report.

KEYWORDS: SIC 4173 (Maintenance facilities for motor vehicle passenger transportation), gasoline, methyl *tert*-butyl ether, MtBE, benzene, toluene, xylene, mechanics.

II. Introduction

In 1992, the Environmental Protection Agency **(EPA)** required the use of oxygenated fuels during winter months in areas within the United States which exceeded the National Ambient Air Quality Standards **(NAAQS)** for carbon monoxide **(CO)**. Due to this mandate, several metropolitan areas within the United States are required to use gasoline containing methyl *tert*-butyl ether **(MtBE)** or ethanol. Due to health complaints possibly associated with the use of MtBE in Alaska, the Centers for Disease Control and Prevention **(CDC)**, National Center for Environmental Health **(NCEH)** was requested to assist in performing a study of persons routinely exposed to motor vehicle exhaust and/or gasoline emissions.

On April 28, 1993, the National Institute for Occupational Safety and Health **(NIOSH)** received a request for technical assistance from the NCEH. NIOSH was asked to assess gasoline-related exposures to workers in conjunction with the EPI-AID investigation **(EPI 93-61-1)** conducted by NCEH. Specifically, NIOSH was asked to evaluate airborne concentrations of MtBE, benzene, xylene, and toluene in workers exposed to gasoline and exhaust emissions. The NCEH investigation included questionnaires and biological monitoring to evaluate exposures to MtBE. This joint investigation included surveys at five facilities in the Albany area from May 3-7, 1993. The New York State Department of Environmental Conservation also conducted ambient air sampling at each of the investigation sites during the week of May 3rd, and collected bulk gasoline samples to submit to an EPA laboratory for analysis of MtBE content.

III. Background

Currently, the United States is the largest consumer of gasoline, using over seven million barrels per day.[1] Considering the amount of gasoline consumed, it is not surprising that motor vehicle exhaust is the greatest single source of air contamination in the U.S. In 1970, the Federal Clean Air Act was developed to reduce emissions of air contaminants, such as carbon monoxide (CO), hydrocarbons, nitrogen oxides, and ozone (as a secondary contaminant) due to the increasing number of cars in use.[2] In an effort to further reduce the levels of CO, amendments to the Clean Air

Act required regions which exceed the NAAQS for CO to use oxygenated fuels containing no less than 2.7% oxygen by weight during the winter months. In most vehicles, an increase in the oxygen content in gasoline enhances the complete burning of the fuel and, thereby, results in a reduction in CO and hydrocarbon emissions. Typically, either ethanol or MtBE is used.[1]

MtBE reduces CO and unburned hydrocarbon emissions in the car's exhaust through fuel enleanment. Studies have shown that CO was reduced by 10% to 35% using 7- and 15-volume percent MtBE blends, whereas, nitrogen oxides and aldehydes were only slightly reduced. However, the study also revealed that the fuel economy was reduced by 1% to 3% when using gasolines containing 7% MtBE blends.[3]

In 1992, there were 100,000 barrels of MtBE produced in the U.S. each day, and it is projected that by mid-1993, the demand for MtBE will be as much as 300,000 barrels per day due to the mandated use of oxygenated fuels. Most likely, the use of this oxygenated fuel will continue to rise because of the requirement to sell reformulated gasoline containing at least 2% oxygen content year round in ozone non-attainment areas beginning January 1995.[1]

IV. Facility Descriptions

A. Empire State Plaza Parking Garage

The Empire State Plaza Parking Garage is located in downtown Albany in the State Capital complex. The garage is a large indoor, three-story, underground parking facility. The parking facility covers approximately 1,000,000 square feet and provides parking for approximately 3200 automobiles. Parking lot attendants worked in booths at the exits of the parking garage collecting parking fees. Employees classified as rovers moved throughout the garage from booth to booth to relieve other employees.

B. Medicab of Albany, Inc.

Medicab is a privately-owned company. The drivers assist and transport patients from nursing homes and hospitals, to other facilities for medical treatment. Additionally, the drivers will pick-up and deliver medical products (e.g., blood).

C. New Salem Garage/Saab Dealership

New Salem Garage has both a Saab dealership and service department; however, the exposure monitoring was performed only in the service department. The service department has 7 mechanics and one service advisor. The service advisor interfaces between the customer and the mechanic and writes up a brief description of the mechanical problem.

The garage is open Monday through Friday from 8 a.m. to 6 p.m. The garage has six service bays, but was not equipped with mechanical local exhaust ventilation. Flexible tailpipe adaptor hoses were available, but relied on the pressure created by the vehicle's exhaust system to push the emissions outdoors through the flexible hoses.

D. Larry's Foreign Auto Service, Inc.

Larry's Foreign Auto Service, Inc., was established in 1975. This automobile repair shop is a single-story, high bay shop with approximately 5000 square feet. There were four full-time mechanics and one service advisor (at the time of our survey one mechanic was on vacation). The shop has six service bays with four car lifts and is open from 7:30 a.m. until 5:30 p.m. During vehicle repair, it is sometimes necessary to operate the engine. The shop was equipped with a mechanical local exhaust ventilation system, with flexible tailpipe adaptor hoses, for the removal of vehicle exhaust emissions.

E. New York State Thruway Maintenance Garage

The New York State Thruway maintenance garage has two vehicle repair shops. At the time of our survey the truck shop employed 23 mechanics, 2 supervisors, 2 welders, 2 painters, 2 janitors, and 1 helper. The auto shop employed 8 mechanics and 1 supervisor. The

garage was open Monday through Friday from 7:30 a.m. to 4:30 p.m. In the truck shop there are 13 service bays for mechanical work, 1 for welding, and 1 for painting of heavy equipment (e.g., dump trucks, snow plows, etc). Each mechanical service bay is equipped with a flexible tailpipe adaptor hose connected to an above-ground mechanical local exhaust ventilation system for the removal of vehicle exhaust emissions.

In the auto shop there are 6 service bays for mechanical work and repairs of automobiles (e.g., State Highway Patrol cars, vans, etc). Each mechanical service bay is equipped with a local exhaust ventilation system similar to the one used in the truck shop.

V. Methods

The environmental evaluation focused on air monitoring, but also included walk-through evaluations of environmental and safety conditions. Air monitoring included evaluation of exposures to MtBE, benzene, toluene, and xylene.

Personal breathing-zone **(PBZ)** air samples for MtBE, benzene, toluene, and xylene were collected onto two sorbent tubes connected in series; the front tube contained 400 milligrams **(mg)** of coconut shell charcoal and the back tube contained 200 mg. The charcoal tubes were connected via Tygon® tubing to Gillian Lo Flow Sampler® battery-operated personal sampling pumps. Air was sampled through the tubes at a nominal flow rate of 0.2 liters per minute **(ℓpm)** for approximately eight hours. After sampling, the charcoal tubes were removed and desorbed in carbon disulfide; an aliquot of this solution was analyzed using gas chromatography-flame ionization detection **(GC-FID)** in accordance with the NIOSH Method 1615 with modifications.[4] The analytical limit of detection **(LOD)** for MtBE, toluene, and xylene is 0.01 milligram per sample **(mg/sample)**, and 0.002 mg/sample for benzene. Due to potential interferences commonly associated with the analysis, gas chromatography with a mass spectrophotometer **(GC/MS)** screening was also performed to confirm the identity of the benzene peaks on random samples.

The sample pumps were calibrated prior to sampling using a Gillian Gilibrator®, which was calibrated against a primary standard. A minimum of 10% of the sampled charcoal tubes were prepared as blanks and submitted with the sample set.

VI. Evaluation Criteria

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ evaluation criteria for the assessment of a number of chemical (and physical) agents. The primary sources of environmental evaluation criteria for the workplace are the following: **1)** NIOSH Criteria Documents and Recommended Exposure Limits **(RELs)**, **2)** the U.S. Department of Labor, Occupational Safety and Health Administration **(OSHA)** Permissible Exposure Limits **(PELs)**, and **3)** the American Conference of Governmental Industrial Hygienists' **(ACGIH)** Threshold Limit Values® **(TLVs)**.[5,6,7] The objective of these criteria for chemical agents is to establish levels of inhalation exposure to which the vast majority of workers may be exposed without experiencing adverse health effects.

Full-shift and shorter duration inhalation criteria are available depending on the specific physiologic properties of the chemical substance. Full-shift limits are based on the time-weighted average **(TWA)** airborne concentration of a substance that most workers may be repeatedly exposed to during a normal eight or 10-hour day, up to 40 hours per week for a working lifetime, without adverse effect. Some substances have recommended short-term exposure limits **(STELs)** or ceiling limits which are intended to supplement the full-shift criteria where there are recognized irritative or toxic effects from brief exposures to high airborne concentrations. STELs are based on TWA concentrations over 15-minute time periods, whereas, ceiling limits are concentrations which should not be exceeded even momentarily.

Occupational health criteria are established based on the available scientific information provided by industrial experience, animal or human experimentation, and epidemiological studies. Differences between the NIOSH RELs, OSHA PELs, and the ACGIH TLVs® may exist because of different scientific philosophy and interpretations of technical information.

When comparing the exposure criteria, it should be noted that **employers are legally required to meet those levels (and any conditions) specified by an OSHA PEL**. The legal rulemaking process for promulgation of OSHA PELs is an arduous and time consuming task and the OSHA PELs may be required to take into account the technical and economical feasibility of controlling exposures in various industries where the agents are used. Hence, OSHA PELs may not be established based on the most current scientific information. In contrast, the NIOSH RELs are primarily based upon the prevention of occupational disease without assessing the economic feasibility of the affected industries and as such tend to be very conservative. ACGIH is not a governmental agency; it is a professional organization whose members are industrial hygienists or other professionals in related disciplines and are employed in the public or academic sector. TLVs® are developed by consensus agreement of the ACGIH TLV® committee and are published annually. The documentation supporting the TLVs® (and proposed changes) is periodically reviewed and updated if believed necessary by the committee. It is not intended by ACGIH for TLVs® to be applied as the threshold between safe and dangerous inhalation exposure.

It is important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these occupational health exposure criteria. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, previous exposures, and/or a hypersensitivity (allergy). In addition, some hazardous substances may act in combination with other workplace exposures, or with medications or personal habits of the worker (such as smoking, etc.) to produce health effects even if the occupational exposures are controlled to the limit set by the evaluation criterion. These combined effects are often not considered by the chemical specific evaluation criteria. Furthermore, many substances are appreciably absorbed by direct contact with the skin and thus potentially increase the overall exposure and biologic response beyond that expected from inhalation alone. Finally, evaluation criteria may change over time as new information on the toxic effects of an agent become available. Because of these reasons, it is prudent for an employer to maintain worker exposures well below established occupational health criteria.

The pertinent evaluation criteria and toxicological background information for the chemical substances evaluated during this technical assistance are presented below:

Gasoline

Gasoline is a clear, volatile petroleum fuel used primarily in internal combustion engines. It is a complex mixture of hydrocarbons compounds, with an overall carbon number range of C_4-C_{12}. The chemical composition can widely vary and depends on the production techniques, seasonal variability, and the addition of additives.[8,9] Previous studies have found that the standard gasoline formulation contains 62% alkanes, 7% alkenes, and 31% aromatics.[10] From a health perspective, exposures to benzene and the lighter hydrocarbons (C_6 or lower) are the constituents of most concern.

Benzene

Benzene is an aromatic organic hydrocarbon containing a six carbon ring with alternating double bonds. Benzene was formerly an important solvent especially in the rubber and surface coating industries, but now is rarely used as a solvent because of its toxicity. It is, however, present as a trace contaminant in gasoline and other petroleum solvents.[11] The nationwide average of benzene content in gasoline is 1.5%, although studies have found benzene content as high as 5%.[10] A previous NIOSH evaluation involving six service stations measured benzene content in gasoline from 0.3 to 1.9%. The exposures to benzene among the service station attendants were measured and the results of the PBZ samples associated with these gasolines ranged from 0.01 to 0.26 parts per million **(ppm)**.[12]

Acute inhalation exposure to high concentrations of benzene can cause drowsiness, fatigue, nausea, vertigo, narcosis, and other symptoms of central nervous system **(CNS)** depression as noted with excessive exposure to other aromatic hydrocarbons.[7,13,14] However, the most remarkable health effects associated with benzene exposure are chronic effects due to repeated exposure to low concentrations over many years.[13]

Benzene is classified by the International Agency for Research on Cancer **(IARC)** as a known human carcinogen and has been associated with irreversible bone marrow injury and the development of hematopoietic toxicity, including aplastic anemia and leukemia in humans.[9,14,15] NIOSH classifies benzene as a human carcinogen, and recommends that occupational exposures be controlled to prevent employees from being exposed to concentrations greater than 0.1 ppm, determined as a TWA concentration for up to 10-hour work shift in a 40-hour work week. NIOSH further recommends a 15-minute STEL of 1.0 ppm. Although NIOSH has established these guidelines which should not be exceeded, the Institute still urges that exposures be reduced to the "lowest feasible level" **(LFL)** because it is not possible to establish thresholds for carcinogens which will protect 100% of the population. The OSHA PEL is 1 ppm for an 8-hour TWA with a 15-minute STEL of 5 ppm. However, the PEL does not apply to "... storage, transportation, distribution, dispensing, sale, or use of gasoline, motor fuels, or other fuels containing benzene subsequent to its final discharge from bulk wholesale storage facilities, except operations where gasoline or motor fuels are dispensed for more than four hours per day in an indoor location..." The current ACGIH TLV® is 10 ppm as a suspected human carcinogen. ACGIH has proposed to lower the TLV® to 0.1 ppm and classify it as a confirmed human carcinogen.

Toluene

Toluene is a colorless, aromatic organic liquid containing a six carbon ring (a benzene ring) with a methyl group (CH_3) substitution. It is a typical solvent found in paints and other coatings, and used as a raw material in the synthesis of organic chemicals, dyes, detergents, and pharmaceuticals. It is also an ingredient of gasoline, ranging from 5% to 22%.[9,10] A previous NIOSH evaluation found toluene content of gasoline ranging from 2.4% to 12%, with exposure levels from none detected to 0.56 ppm.[12]

Inhalation and skin absorption are the major occupational routes of entry. Toluene can cause acute irritation of the eyes, respiratory tract, and skin. Since it is a defatting solvent, repeated or prolonged skin contact will remove the natural lipids from the skin which can cause drying, fissuring, and dermatitis.[13,16]

The main effects reported with excessive (inhalation) exposure to toluene are CNS depression and neurotoxicity.[13] Studies have shown that subjects exposed to 100 ppm of toluene for six hours complained of eye and nose irritation, and in some cases, headache, dizziness, and a feeling of intoxication (narcosis).[17,18,19] No symptoms were noted below 100 ppm in these studies. There are a number of reports of neurological damage due to deliberate sniffing of toluene-based glues resulting in motor weakness, intention tremor, ataxia, as well as cerebellar and cerebral atrophy.[20] Recovery is complete following infrequent episodes, however, permanent impairment may occur after repeated and prolonged glue-sniffing abuse. Exposure to extremely high concentrations of toluene may cause mental confusion, loss of coordination, and unconsciousness.[21,22]

Originally, there was a concern that toluene exposures produced hematopoietic toxicity because of the benzene ring present in the molecular structure of toluene. However, toluene does not produce the severe injury to bone marrow characteristic of benzene exposure as early reports suggested. It is now believed that simultaneous exposure to benzene (present as a contaminant in the toluene) was responsible for the observed toxicity.[11,16]

The NIOSH REL for toluene is 100 ppm for an 8-hour TWA. NIOSH has also set a recommended STEL of 150 ppm for a 15-minute sampling period. The OSHA PEL for toluene is 200 ppm for an 8-hour TWA. The recently adopted ACGIH TLV® is 50 ppm for an 8-hour exposure level. This ACGIH TLV® carries a skin notation, indicating that cutaneous exposure contributes to the overall absorbed inhalation dose and potential systemic effects.

Xylene

Xylene is a colorless, flammable organic liquid with a molecular structure consisting of a benzene ring with two methyl group (CH_3) substitutions. Xylene is used in paints and other coatings, as a raw material in the synthesis of organic chemicals, dyes, and pharmaceuticals. It is also an ingredient of gasoline (ranging from 1% to 10%) and many other petroleum solvents.[11] A NIOSH investigation of service station attendants found xylene content in gasoline ranging from 3.3% to 22%.[12]

The vapor of xylene has irritant effects on the skin and mucous membranes, including the eyes and respiratory tract. This irritation may cause itching, redness, inflammation, and discomfort. Repeated or prolonged skin contact may cause erythema, drying, and defatting which may lead to the formation of vesicles. At high concentrations, repeated exposure to xylene may cause reversible damage to the eyes.[13]

Acute xylene inhalation exposure may cause headache, dizziness, incoordination, drowsiness, and unconsciousness.[23] Previous studies have shown that concentrations from 60 to 350 ppm may cause giddiness, anorexia, and vomiting.[13] At high concentrations, exposure to xylene has a narcotic effect on the CNS, and minor reversible effects on the liver and kidneys.[13,23,24]

Historical accounts of hematopoietic toxicity as a result of xylene exposure are likely due to the high concentration of benzene contamination in xylene prior to 1940. These effects previously reported are no longer associated with contemporary xylene exposure.[23,25,26]

The current OSHA PEL, NIOSH REL, and ACGIH TLV for xylene are 100 ppm over an 8-hour TWA. In addition, OSHA and NIOSH have published STELs for xylene of 150 ppm averaged over 15 minutes.

Methyl tert-butyl ether

Methyl tert-butyl ether **(MtBE)** is a colorless, flammable liquid derived from the catalytic reaction of methanol and isobutene. It is a volatile organic ether containing 18.2% oxygen and has low odor threshold (0.06 ppm).[27] MtBE is manufactured in petrochemical plants and refineries. Originally, it was used as a fuel additive to increase the octane grade following the mandated EPA lead phase-down, and is currently used to reduce air pollution.[1] MtBE has also been used in clinical medicine to dissolve cholesterol stones in the biliary tract.[28,29]

The primary route of exposure to workers is through inhalation which may occur during production, blending, and transportation. The primary source of potential exposure to the general public is from vapors from MtBE blended gasolines.

Several animal studies have been performed to evaluate the toxicity of MtBE. In rats, the acute oral lethal dose **(LD_{50})** has been reported as 4 grams per kilogram. The acute lethal concentration **(LC_{50})** for rats was reported from 23,630 to 33,000 ppm in air for a 4-hour period.[30,31] Studies performed with mice, rats, and rabbits indicate that the no observed effect level **(NOEL)** ranged from 800 to 2500 ppm.[32] MtBE was not found to be maternally toxic, embryotoxic, or teratogenic, and showed little adverse reproductive toxicity.[33,34]

In rats, the ethereal bond is broken in MtBE, producing tertiary butyl alcohol **(TBA)**. MtBE and TBA concentrations in blood and brain of rats increased in a dose-dependent manner, although the MtBE concentration resulting from the 50 ppm exposures tended to decrease after a period of time. MtBE was also found in perirenal fat.[35]

The initial investigation in Alaska performed by NCEH in December 1992, in which the MtBE and its TBA were measured in human blood revealed a strong correlation between ambient MtBE concentrations and MtBE found in the blood.[36]

Previous studies have measured airborne MtBE levels below 5 ppm at manufacturing plants and a marketing terminal. The mean full-shift PBZ exposures increased to 15 ppm and 31 ppm for refineries and marine barges, respectively.[37,38] A NIOSH investigation of service station attendants reported MtBE concentrations ranging from none detected to approximately 4 ppm in facilities which used gasoline containing less than 1% to 12% of this additive.[12]

Acute exposures to MtBE may cause irritation to the skin, eyes, and mucous membranes. However, MtBE does not cause dermal sensitization. At extremely high concentrations, MtBE may induce CNS depression.[31] Based on the NOEL, the American Industrial Hygiene Association **(AIHA)** established a workplace environmental

exposure level **(WEEL)** of 100 ppm for an 8-hr TWA.[32] At this time, NIOSH, OSHA, and ACGIH have not established exposure criteria for MtBE.

VII. Results and Discussion

A. Overall Study Results

A total of 24 personal breathing-zone air samples were collected to assess worker exposures to benzene, toluene, xylene, and MtBE at five facilities. The TWA exposure concentrations and durations for each individual facility are presented in Tables 1-5.

Many factors influenced the results of this study. Since sampling was performed in May, dilution ventilation (which includes open windows and service doors) played a significant role in reducing indoor exposures. Also, some workers did not work on gasoline-powered vehicles or did not spend a majority of time in their vehicles, and therefore, the concentrations reported may under-estimate exposures for these job categories. Based on these factors, the levels discussed in this report may not be characteristic of the higher indoor workplace exposures to MtBE, toluene, xylene, and benzene which may occur at
other times, such as during the winter (with lower dilution ventilation rates) or changes in work activities.

Personal exposures to toluene and xylene ranged from less than 0.03 to 0.73 ppm, and less than 0.02 to 0.43 ppm, respectively. These levels are well below the pertinent occupational health exposure criteria and are slightly lower than the concentrations found in previous NIOSH studies of service station attendants and mechanics.[12,39]

It should be noted that one employee working in the auto body shop of the New State Thruway maintenance garage (please refer to Table 5) had the highest toluene and xylene levels, 9.8 ppm and 1.0 ppm, respectively. These values were considerably higher than the range reported above. Because the employee worked at a spray painting operation and his exposures were different than those expected for mechanics these values are not included in the range of levels reported above.

MtBE exposure levels ranged from less than 0.03 ppm to 0.14 ppm, levels well below the AIHA WEEL of 100 ppm. Mechanics who worked on the vehicles' fuel systems tend to have slightly higher MtBE

Table 1

Personal Breathing-Zone Exposures
State of New York - Empire State Plaza Parking Garage
May 3, 1993

Job Title	Sample Time (min)	Time-Weighted Average Concentrations (parts per million)			
		MtBE	Toluene	Xylene	Benzene
Attendant - P3-North	434	<0.03	<0.03	<0.02	(0.010)
Attendant - P1-North	479	<0.03	<0.03	<0.02	<0.006
Rover	413	<0.03	(0.06)	(0.06)	0.025
NCEH - Medical Officer	487	<0.03	<0.03	<0.02	(0.006)
Attendant - P3-North	472	<0.03	<0.03	<0.02	<0.006
Garage Office Secretary	458	<0.03	<0.03	<0.02	<0.006
Rover	166	<0.03	<0.03	<0.02	<0.006
Attendant - P3-South	273	<0.03	(0.05)	<0.02	(0.017)
Attendant - P1-North	290	<0.03	<0.03	<0.02	(0.022)
Attendant - P3-South	252	<0.03	(0.11)	(0.05)	0.034
Minimum Detectable Concentration (MDC)**		0.03	0.03	0.02	0.006
Minimum Quantifiable Concentration (MQC)**		0.09	0.09	0.08	0.017
EVALUATION CRITERIA					
NIOSH Recommended Exposure Limit		---	100	100	0.1†
OSHA Permissible Exposure Limit		---	200	100	1
ACGIH Threshold Limit Value		---	50*	100	10‡

( ) Denotes value between MDC and MQC
--- There are no recommended exposure limits developed by NIOSH, OSHA, or ACGIH.
However, the AIHA workplace environmental exposure level is 100 ppm for an 8-hr TWA.
† Human carcinogen
‡ Suspected human carcinogen
* Skin notation
** MDC/MQC calculation based on a maximum air volume of 98.6 liters.

Table 2

Personal Breathing-Zone Exposures
Medicab of Albany
May 4, 1993

Job Title	Sample Time (min)	Time-Weighted Average Concentrations (parts per million)			
		MtBE	Toluene	Xylene	Benzene
Medical taxi driver	372	<0.03	<0.03	<0.02	(0.008)
Minimum Detectable Concentration (MDC)**		0.03	0.03	0.02	0.006
Minimum Quantifiable Concentration (MQC)**		0.09	0.09	0.08	0.017
EVALUATION CRITERIA					
NIOSH Recommended Exposure Limit		---	100	100	0.1†
OSHA Permissible Exposure Limit		---	200	100	1
ACGIH Threshold Limit Value		---	50*	100	10‡

( ) Denotes value between MDC and MQC
--- There are no recommended exposure limits developed by NIOSH, OSHA, or ACGIH.
However, the AIHA workplace environmental exposure level is 100 ppm for an 8-hr TWA.
† Human carcinogen
‡ Suspected human carcinogen
* Skin notation
** MDC/MQC calculation based on a maximum air volume of 98.6 liters.

Table 3

Personal Breathing-Zone Exposures
New Salem Garage/Saab Dealership
May 5, 1993

Job Title	Sample Time (min)	Time-Weighted Average Concentrations (parts per million)			
		MtBE	Toluene	Xylene	Benzene
Mechanic	481	<0.03	(0.06)	(0.05)	0.020
Service Advisor	453	<0.03	(0.06)	(0.05)	(0.014)
Mechanic	450	<0.03	(0.06)	(0.05)	(0.017)
Mechanic	347	0.14	0.73	0.33	0.054
Mechanic	470	(0.06)	(0.06)	(0.05)	(0.013)
Maintenance/New car prep	451	<0.03	(0.06)	(0.05)	(0.014)
Minimum Detectable Concentration (MDC)**		0.03	0.03	0.02	0.006
Minimum Quantifiable Concentration (MQC)**		0.09	0.09	0.08	0.017
EVALUATION CRITERIA					
NIOSH Recommended Exposure Limit		---	100	100	0.1†
OSHA Permissible Exposure Limit		---	200	100	1
ACGIH Threshold Limit Value		---	50*	100	10‡

( ) Denotes value between MDC and MQC
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However, the AIHA workplace environmental exposure level is 100 ppm for an 8-hr TWA.
† Human carcinogen
‡ Suspected human carcinogen
* Skin notation
** MDC/MQC calculation based on a maximum air volume of 98.6 liters.

Table 4

Personal Breathing-Zone Exposures
Larry's Foreign Auto Service, Inc.
May 6, 1993

Job Title	Sample Time (min)	Time-Weighted Average Concentrations (parts per million)			
		MtBE	Toluene	Xylene	Benzene
Service Advisor	453	<0.03	(0.03)	(0.05)	<0.006
Mechanic	455	<0.03	(0.06)	0.43	(0.010)
Mechanic	444	<0.03	(0.06)	0.24	(0.014)
Service Advisor/Mechanic	443	<0.03	(0.06)	0.42	(0.011)
Minimum Detectable Concentration (MDC)**		0.03	0.03	0.02	0.006
Minimum Quantifiable Concentration (MQC)**		0.09	0.09	0.08	0.017
EVALUATION CRITERIA					
NIOSH Recommended Exposure Limit		---	100	100	0.1†
OSHA Permissible Exposure Limit		---	200	100	1
ACGIH Threshold Limit Value		---	50*	100	10‡

( ) Denotes value between MDC and MQC
--- There are no recommended exposure limits developed by NIOSH, OSHA, or ACGIH.
However, the AIHA workplace environmental exposure level is 100 ppm for an 8-hr TWA.
† Human carcinogen
‡ Suspected human carcinogen
* Skin notation
** MDC/MQC calculation based on a maximum air volume of 98.6 liters.

Table 5

Personal Breathing-Zone Exposures
New York State Thruway Maintenance Garage
May 7, 1993

Job Title	Sample Time (min)	Time-Weighted Average Concentrations (parts per million)			
		MtBE	Toluene	Xylene	Benzene
Laborer/truck shop	343	<0.03	<0.03	<0.02	<0.006
Auto body shop	364	<0.03	9.8	1.0	0.047
Mechanic/car shop	309[a]	<0.03	(0.13)	(0.08)	<0.006
Minimum Detectable Concentration (MDC)**		0.03	0.03	0.02	0.006
Minimum Quantifiable Concentration (MQC)**		0.09	0.09	0.08	0.017
EVALUATION CRITERIA					
NIOSH Recommended Exposure Limit		---	100	100	0.1†
OSHA Permissible Exposure Limit		---	200	100	1
ACGIH Threshold Limit Value		---	50*	100	10‡

( ) Denotes value between MDC and MQC
--- There are no recommended exposure limits developed by NIOSH, OSHA, or ACGIH.
However, the AIHA workplace environmental exposure level is 100 ppm for an 8-hr TWA.
† Human carcinogen
‡ Suspected human carcinogen
* Skin notation
** MDC/MQC calculation based on a maximum air volume of 98.6 liters.
a Pump shut off for 47 minute period due to pinched hose

exposures. MtBE was detected on only two of twenty-four samples. The highest MtBE exposure measured in this evaluation, 0.14 ppm, was obtained from a mechanic.

Benzene exposure levels ranged from less than 0.006 ppm to 0.054 ppm. None of the samples collected exceeded the NIOSH recommendation of 0.1 ppm. Four of the 24 samples showed airborne concentrations of benzene above the MQC. The highest benzene concentration was from a mechanic who performed several tune-ups the day of sampling. The second highest benzene concentration was from an auto body shop worker who was involved in the spray painting of vehicles at the highway maintenance garage. The other two samples were from workers at the indoor parking garage. It is not known why these two individuals had exposures greater than their co-workers.

B. Results by Job Type

Table 6 presents a summary of the results according to job type. The results were divided into four categories: 1) mechanics, 2) parking lot attendants, 3) "other" (a category which includes job titles, such as maintenance, medical taxi driver, NCEH medical officer, office secretary, and service advisors), and 4) the fourth category was comprised of the one auto body shop worker, this individual was separated from the other groups due to the fact that his job involved exposures to unique to his job. It is important to note that most of the mechanics who were monitored did not do engine work on the days of the survey. However, these workers were classified according to their job title, even though some of their exposures may not be representative of the remaining people in these categories.

Table 6 shows the range of concentrations for each contaminant and the median value. In general, the highest median concentrations were measured on the mechanics, followed by the parking lot attendants. The workers' exposures to toluene, xylene, and MtBE in all four categories were all below the applicable criteria. The mechanics had slightly higher exposures to toluene and xylene, due in part to the use of cleaning solvents which contained these chemicals.

Table 6
Summary of Results by Job Type
(parts per million)

Job Type	n	MtBE		TOLUENE		XYLENE		BENZENE	
		Range	Median	Range	Median	Range	Median	Range	Median
Mechanics	8	<0.03 - 0.14	0.03	0.06 - 0.73	0.06	0.05 - 0.43	0.16	0.006 - 0.054	0.014
Parking Lot Attendants	8	<0.03	0.03♦	<0.03 - 0.11	0.03	<0.02 - 0.06	0.02	<0.006 - 0.034	0.014
Others	7	<0.03	0.03♦	<0.03 - 0.06	0.03	<0.02 - 0.05	0.02	<0.006 - 0.014	0.006
Autobody shop	1	<0.03	NA	9.8	NA	1.0	NA	0.047	NA
EVALUATION CRITERIA									
NIOSH Recommended Exposure Limit		---		100		100		0.1†	
OSHA Permissible Exposure Limit		---		200		100		1	
ACGIH Threshold Limit Value		---		50*		100		10‡	

n number of data points
† Human carcinogen
‡ Suspected human carcinogen
* Skin notation
♦ Since all values were less than the MCD this value is estimated.
NA not applicable

VIII. Conclusions and Recommendations

This technical assistance was initiated as a result of concerns regarding exposures to gasoline and exhaust emissions. However, since the sampling was performed in late spring, natural convection through open windows and service doors added dilution air to the work areas and reduced the concentration of air contaminants. Therefore, the environmental results obtained from this evaluation may under-estimate the indoor workplace exposures to MtBE, toluene, xylene, and benzene which may actually occur during the winter when the effect from dilution ventilation is at a minimum. In order to evaluate worst case exposures, it would be necessary to perform air monitoring during winter months.

The use of MtBE is not restricted to areas which exceed the National Ambient Air Quality Standards **(NAAQS)** for carbon monoxide **(CO)**. This chemical can be used in gasoline formulations anywhere it is available. The analytical results of bulk gasoline samples collected by the New York State Department of Environmental Conservation were verbally reported to the NIOSH investigator by the NCEH medical officer, and these results indicate that MtBE was present in gasolines found in the Albany area in concentrations of up to 10%.

Personal breathing-zone air sampling showed that TWAs for benzene, toluene, and xylene were all within the NIOSH RELs, OSHA PELs, and ACGIH TLVs®. Occupational exposures to MtBE were less than 0.14 ppm, or less than 0.2% of AIHA WEEL of 100 ppm. Recommendations regarding potential chemical exposures and safety issues are presented below. These recommendations are applicable to most of the sites evaluated.

1. Worker inhalation and dermal exposures to benzene, toluene, and xylene can be reduced by prohibiting the use of "raw gasoline" as a cleaning agent. An effective, but less hazardous cleaning, product should be substituted for gasoline.

2. Local exhaust ventilation should be installed at operations where solvents and other volatile substances are used. In situations where local exhaust ventilation is not feasible, general ventilation can be used to increase the amount of outside air introduced into a work area. Properly distributed, this outside air will dilute the contaminants and

thereby, reduce the workers' exposures. Provisions should be made toensure that outside air is provided throughout the year and is properly distributed.

3. Cigarette smoke may interact with chemical substances used at these sites. In addition, reports from the Surgeon General, the National Research Council and the EPA have concluded that exposure to environmental tobacco smoke **(ETS)** may be associated with a wide range of health (e.g., lung cancer) and comfort (e.g., eye, nose, and throat irritation and odor) effects. NIOSH has determined that ETS may be related to an increased risk of lung cancer and possibly heart disease in occupationally-exposed workers who do not smoke themselves. NIOSH recommends that the use of tobacco products be curtailed in these situations and where non-smoking workers may be exposed to side-stream cigarette smoke. The best method for controlling worker exposure to tobacco smoke is to eliminate smoking from the workplace. Until this is achieved, smoking should be restricted to outside the facility or to a designated area such as a smoking room which has additional ventilation. The air from this area should be exhausted directly to the outside and not recirculated within the building.[40]

4. Labeling of chemicals, worker training, and other aspects of hazard communication should conform with the OSHA Hazard Communication rule 29 Code of Federal Regulations **(CFR)** 1910.1200. This federal regulation requires every company to transmit all information regarding the hazards of the chemicals used at their facility to their employees. This can be accomplished by means of a comprehensive hazard communication program, which includes a written program, labeling of chemical containers which includes identifying the contents and any known hazards that are associated with that material, distribution of accurate and updated Material Safety Data Sheets **(MSDS)**, and employee training regarding the hazards of chemicals and protective measures which should be taken. Employee training should include identifying the physical and health hazards of the chemicals in the work area; the measures employees can take to protect themselves from these hazards; an explanation of both the labeling system and MSDS, and how the employees can obtain and use this information.

5. Eye trauma from foreign bodies is preventable. All facilities should institute and enforce programs requiring the use of protective eye wear, such as safety glasses and splash goggles.

6. Eating and drinking should be prohibited in areas where there is a potential for significant exposures to hazardous chemicals.

7. Safety equipment, including eye wash stations, safety showers, and fire extinguishers should be installed, inspected on a routine basis, and maintained in good operating condition.

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