NIOSH HEALTH HAZARD EVALUATION REPORT

HETA #2004-0184-2965
City of Los Angeles, Bureau of Street Services
Los Angeles, California

April 2005

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

PREFACE

The Hazard Evaluation and Technical Assistance Branch (HETAB) of the National Institute for Occupational Safety and Health (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 (OSHA) 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 employers or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

HETAB also provides, upon request, technical and consultative assistance 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. Mention of company names or products does not constitute endorsement by NIOSH.

ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Robert E. McCleery, MSPH, CIH and Loren Tapp, MD, MS. Field assistance was provided by Gregory A. Burr, CIH of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Analytical support was provided by Data Chem Laboratories, Salt Lake City, Utah. Desktop publishing was performed by Shawna Watts and Robin Smith. Editorial assistance was provided by Ellen Galloway.

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Highlights of the NIOSH Health Hazard Evaluation

Evaluation of Exposures to Asphalt Plant Operators and Truck Drivers

In March 2004, NIOSH received a confidential employee request for a health hazard evaluation at the City of Los Angeles, Bureau of Street Services Asphalt Plant 1, Los Angeles, California. The request concerned exposure to fumes, vapors, work and heat stress, and diesel fuel during asphalt processing and during asphalt delivery to paving projects. The request mentioned some employees had experienced a variety of health symptoms including cancer, respiratory symptoms, and hearing problems that they believed were work-related.

What NIOSH Did

- We took personal breathing zone (PBZ) air samples on plant workers and truck drivers as well area air samples around Plant 1.
- We tested for compounds which may be found in asphalt fume. We also checked for diesel exhaust and carbon monoxide (CO). Some of these compounds do not have occupational exposure limits, however.
- We talked to employees about job duties, work locations, and possible work-related symptoms.
- We looked at OSHA 200 and 300 logs and worker compensation claims for any reported health problems.

What NIOSH Found

- PBZ air samples concentrations were below occupational exposure limits.
- We found a hole in the duct-work inside the asphalt loading area. This makes the ventilation system less effective.
- We found personal protective equipment such as respirators and gloves that were not stored properly and were old and outdated.
- The majority of workers we talked to reported that they had no work-related health symptoms.

What LABSS Managers Can Do

- Make sure that ventilation systems are working correctly. Repair any holes in the ducts.
- Design a communication system for asphalt truck drivers so they do not have to open their windows while loading asphalt.
- Dispose of all outdated gloves and respirators.
- Make sure the Plant 1 respirator program is up-to-date and all requirements are being followed.
- Place hearing protection signs in areas where hearing protection is required.

What LABSS Employees Can Do

- Report any health problems that you think may be work-related to LABSS.
- Keep truck windows closed as much as possible while in the asphalt loading area.

CDC Workplace Safety and Health

What To Do For More Information:
We encourage you to read the full report. If you would like a copy, either ask your health and safety representative to make you a copy or call 1-513-841-4252 and ask for HETA Report 2004-0184-2965

NIOSH

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SUMMARY

On March 19, 2004, the National Institute for Occupational Safety and Health (NIOSH) received a confidential employee request for a health hazard evaluation (HHE) at Asphalt Plant 1 of the City of Los Angeles, Bureau of Street Services (LABSS) located in Los Angeles, California. The request expressed concern about exposure to fumes, vapors, work stress, heat stress, and diesel fuel during asphalt processing at Plant 1 and during delivery of this asphalt to paving projects. The request indicated that LABSS employees had experienced a variety of health symptoms including cancer, respiratory symptoms, and hearing problems. In response to this request, NIOSH investigators conducted a site-visit on September 13-15, 2004.

NIOSH investigators collected 19 general area (GA) and personal breathing zone (PBZ) air samples for total particulate with additional analysis for the benzene-soluble fraction of this particulate; 19 GA and PBZ air samples for polycyclic aromatic compounds with additional analysis for total organic sulfur compounds; 19 GA and PBZ air samples for diesel exhaust (elemental and organic carbon); and eight GA real-time, data-logged air samples for carbon monoxide.

NIOSH investigators interviewed 25 of 26 employees of Asphalt Plant 1 and reviewed LABSS compensation claims, OSHA logs, and a company sick-time study.

All the air sample concentrations for compounds listed above were below relevant occupational exposure criteria. The majority of interviewed workers (21 of 25) reported that they had no work-related health symptoms. Of those with symptoms, the most common was eye irritation, followed by headache.

Based on the low air sample concentrations found and the low rate of work-related health complaints during medical interviews with employees, there does not appear to be a health hazard at City of Los Angeles, Bureau of Street Services, Asphalt Plant 1. The transient eye, nasal, and throat irritation symptoms reported by some employees are consistent with exposures to asphalt fumes and particulates at levels below recommended limits. The current scientific literature has determined that there is inadequate evidence that asphalt alone increases cancer risk to humans. Recommendations to minimize work exposures are provided and include the following: repair damage to existing ventilation systems, improve asphalt loading work practices, dispose of outdated personal protective equipment, and improve the existing respiratory and hearing protection programs.

Keywords: 2951 (Asphalt Paving Mixtures and Blocks), asphalt, particulate, benzene-soluble, polycyclic aromatic compounds, PAC, sulfur, diesel, carbon monoxide, cancer, respiratory, hearing

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INTRODUCTION

On March 19, 2004, the National Institute for Occupational Safety and Health (NIOSH) received a confidential employee request for a health hazard evaluation (HHE) at Asphalt Plant 1 of the City of Los Angeles, Bureau of Street Services (LABSS) located in Los Angeles, California. The request expressed concern about work stress, heat stress, and exposure to fumes, vapors, and diesel fuel from asphalt processing at Plant 1, and the delivery of this asphalt to paving projects. The request indicated that LABSS employees had experienced a variety of health symptoms including cancer, respiratory symptoms, and hearing problems that were perceived to be work-related. In response to this request, NIOSH investigators conducted a site-visit on September 13-15, 2004.

On September 13, 2004, the site-visit began with an opening conference and facility tour. The environmental evaluation on September 14 and 15, 2004 consisted of general area (GA) and personal breathing zone (PBZ) air sampling for components of asphalt fume and diesel exhaust. This included sampling for total particulate and its corresponding benzene-soluble fraction (BSF), polycyclic aromatic compounds (PAC) which includes polynuclear aromatic hydrocarbons (PAH), organic sulfur compounds (OSC), diesel exhaust (elemental and organic carbon [EC/OC], and carbon monoxide (CO). On September 14, 2004, the NIOSH medical officer conducted confidential employee interviews and a review of documents such as Occupational Safety and Health Administration (OSHA) injury and illness logs and worker's compensation records.

BACKGROUND

The City of Los Angeles has three plants which manufacture asphalt for paving operations in the city and its surrounding areas. Asphalt Plant 1 is located in the downtown Los Angeles area. Employees located at Asphalt Plant 1 include plant operators, maintenance/laborers, heavy equipment operator, truck drivers, contractors, and administrative and supervisory staff. The plant operators and truck drivers are represented by the Service Employees International Union (SEIU) Local 347. Employees report to the plant on staggered schedules beginning at 4:30 a.m. and work an average of 8 hours a day, 5 days a week. Frequently, smaller numbers of employees are needed for evening or weekend paving jobs. In addition to providing the Metropolitan district of Los Angeles with road maintenance and repair, the City also contracts with other entities, such as the Los Angeles International Airport, for paving jobs.

Depending on the paving site location, truck drivers receive at any of the 3 LABSS asphalt plants. Drivers typically deliver an average of 3-5 loads of asphalt per day. Between 20 and 30 truck drivers report to the Plant 1 location; the majority of which haul hot asphalt to the paving sites. A fewer number of drivers transport paving equipment to sites or road millings to an asphalt recycling plant.

In designated areas of Asphalt Plant 1, employees are required to wear one or a combination of the following items of personal protective equipment (PPE): hard hats, safety shoes, hearing protection, coveralls, face shields or eye protection, leather gloves, and an N-95 filtering facepiece. Plant operators wear respirators when they need to work on the conveyor belts carrying aggregate or hot asphalt and during plant maintenance.

PROCESS DESCRIPTION

Sand and various sized aggregate are delivered to the plant where it is placed into individual storage bins by the heavy equipment operator. This material is transferred by conveyor to a dryer and heated to between 325-350ºF to remove most of the moisture and then conveyed to a shaker for screening. From the screener the appropriate sized aggregate is then sent to a mixer where hot asphalt cement is added from a heated underground tank referred to as the "soup pot". The asphalt-coated aggregate is then moved by a drag conveyor to two silos prior to

distribution to asphalt trucks. The asphalt trucks are driven underneath the silos into a ventilated booth where asphalt is dropped into truck beds. Based on worker's descriptions, the asphalt drop booth was an enclosed area with little to no ventilation. However, during the past 10 years the ventilation has improved with the addition of a dust and asphalt fume collection system which also recycled this material back into the asphalt mix.

Plant operators assign asphalt trucks to paving projects based on the amount needed for the particular paving job. Asphalt Plant 1 produces an average of 1000-1500 tons of asphalt daily. The asphalt does not contain crumb rubber additives, and no recycled asphalt has been used at the plant for nearly a year. Prior to that, the plant used about 15% recycled asphalt in the mix.

METHODS

Industrial Hygiene

Total Particulate (TP) and Benzene-soluble Fraction (BSF)

GA and PBZ air samples for TP were collected on tared 37-millimeter (mm) diameter, 2-micrometer (µm) pore-size polytetrafluoroethylene (PTFE) filters, at a calibrated flow rate of 2.0 liters per minute (Lpm). The filters were gravimetrically analyzed (filter weight) and subsequently analyzed for its BSF according to NIOSH Method 5042.[1] The analytical limit of detection (LOD) for both the TP and BSF on the PTFE filters was 0.02 milligrams (mg) which equates to a minimum detectable concentration (MDC) of 0.02 milligrams per cubic meter of air (mg/m^3), assuming a sample volume of 1000 liters. The analytical limit of quantification (LOQ) for both the TP and BSF on the PTFE filters was 0.05 mg, which equates to a minimum quantifiable concentration (MQC) of 0.05 mg/m^3, assuming a sample volume of 1000 liters.

Polycyclic Aromatic Compounds (PAC)

GA and PBZ air samples for PACs were collected on 37-mm diameter, 2-µm pore-size PTFE filters followed by an ORBO 42 sorbent tube at a calibrated flow rate of 1.0 Lpm. The filters were analyzed according NIOSH Method No. 5800.[1] Opaque filter cassettes and sorbent tube holders were used to prevent the degradation of PACs by ultraviolet light. This method identifies PACs via High Performance Liquid Chromatography (HPLC) and a flow injection technique with spectrofluorometric detection. Two detector emission wavelengths were used: 370 nanometers (nm), a wavelength which is more sensitive to 2-3 ring PACs; and 400 nm, which is more sensitive to 4+ ring PACs. See the Results and Discussion sections for further information concerning the sampling for PACs.

Organic Sulfur-containing Compounds (OSC)

The PAC filters described above were also analyzed for total OSCs which may be present in crude petroleum. Sulfur compounds were analyzed by gas chromatography with sulfur chemiluminescence detection. The analytical LOD for OSCs was 6 µg/sample, which is equivalent to a MDC of 12 $µg/m^3$, assuming a sample volume of 500 liters. The analytical LOQ for the OSCs was 19 µg/sample, which is equivalent to a MQC of 38 $µg/m^3$, assuming a sample volume of 500 liters.

In this report OSCs refer to aliphatic and aromatic organic compounds that contain sulfur. Although no specific occupational exposure limits exist for this group of sulfur compounds, some of these compounds may cause respiratory irritation.[10]

Diesel Exhaust (Elemental Carbon/Organic Carbon [EC/OC])

GA air samples for diesel exhaust - EC/OC were collected with open-faced filter cassettes on 37-mm diameter glass-fiber filters, at a calibrated flow rate of 2.0 Lpm. The filters were analyzed according to NIOSH Method 5040.[1] The analytical LOD for elemental carbon was 0.17 µg/sample, which is equivalent to a MDC of 0.17 µg/m^3, assuming a sample volume of 1000 liters. The analytical LOQ for the elemental carbon was 0.43 µg/sample, which is equivalent to a MQC of 0.43 µg/m^3, assuming a sample volume of 1000 liters. The analytical LOD for organic carbon was 1.7 µg/sample, which is equivalent to a MDC of 1.7 µg/m^3, assuming a sample volume of 1000 liters. The analytical LOQ for organic carbon was 6.8 µg/sample, which is equivalent to a MQC of 6.8 µg/m^3, assuming a sample volume of 1000 liters.

NIOSH Method 5040 analyzes for elemental and organic carbon. Both are used surrogates of diesel particulate emissions given that a considerable portion of the diesel emission is carbon.[2,3,4] However, organic carbon may originate from many sources other than from diesel exhaust, such as cigarette smoke, asphalt fumes, and other combustion products. For this reason, elemental carbon is the preferred surrogate because diesel engines are its primary source and there is minimal contribution from the other sources listed above.[5,6]

Carbon monoxide (CO)

CO concentrations were measured at GA work locations using direct-reading, data logging ToxiUltra Atmospheric Monitors (Biometrics, Inc.) with CO sensors. All ToxiUltra CO monitors were zeroed and calibrated according to the manufacturer's recommendations and operated in the passive diffusion mode, with a one-minute sampling interval. The instruments have a nominal range from 0-500 ppm with the highest instantaneous reading of 1000 ppm.

Medical

All hourly employees working at LABSS Asphalt Plant 1, including plant operators, plant maintenance, plant equipment operator, equipment mover truck operators, or heavy duty truck operators, were offered a confidential medical interview.

OSHA injury and illness logs (OSHA 200 and 300 logs) were reviewed for cases of respiratory disease and cancer. Additionally, the City provided worker compensation claim records for the LABSS from the years 1977 to present, and a comparison of annual sick time off between asphalt plant employees and non-asphalt plant employees (with similar jobs but without asphalt exposure) from the first 10 months of 2004.

EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for the 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, however, important to note that not all workers will be protected from adverse health effects even though their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing 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 criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increases the overall exposure. Finally, evaluation criteria

may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: (1) NIOSH Recommended Exposure Limits (RELs),[7] (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®),[8] and (3) the U.S. Department of Labor, OSHA Permissible Exposure Limits (PELs).[9] Employers are encouraged to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criteria.

OSHA requires an employer to furnish employees a place of employment that is free from recognized hazards that are causing or are likely to cause death or serious physical harm [Occupational Safety and Health Act of 1970, Public Law 91-596, sec. 5(a)(1)]. Thus, employers should understand that not all hazardous chemicals have specific OSHA exposure limits such as PELs and short-term exposure limits (STELs). An employer is still required by OSHA to protect their employees from hazards, even in the absence of a specific OSHA PEL.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended STEL or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from higher exposures over the short-term.

Asphalt Fume (Petroleum)

The specific chemical content of asphalt, a brown or black solid or viscous liquid at room temperature, is difficult to characterize because it is extremely complex and variable. In general, asphalt primarily contains high molecular weight cyclic hydrocarbon compounds as well as saturated organic compounds. Its chemical composition and physical properties are influenced by the original crude petroleum and the manufacturing processes; however, the basic chemical components of asphalt include paraffinic, naphthenic, and aromatic hydrocarbons as well as heteroaromatic compounds containing sulfur, oxygen, and nitrogen.[10]

Petroleum based asphalt and coal-tar pitch are often considered to be equivalent materials because of their similar physical appearance and construction applications. However, these materials are quite different chemically as a result of different raw material origins and manufacturing processes.[11] More than 90% of the carbon in coal-tar pitch condensates is in aromatic rings, while in asphalt fume condensates less than 1% of the carbon is in aromatic rings.[12] Furthermore, coal-tar has a greater reported carcinogenic activity than asphalt and is considered an occupational carcinogen. Petroleum-based asphalt was used at all seven paving sites.

Nonmalignant lung diseases such as bronchitis, emphysema, and asthma have been associated with exposure to asphalt fumes.[13,14] In a study of road repair and construction work, three groups of asphalt workers experienced abnormal fatigue, reduced appetite, eye irritation, and laryngeal/pharyngeal irritation.[15] Results of previous studies in asphalt pavers have been inconsistent with regard to lung cancer; some studies have shown an increased risk but are limited because they did not account for factors such as smoking history and co-exposure to coal tar and other potential lung carcinogens (e.g., diesel exhaust, polyaromatic hydrocarbons, benzo-a-pyrene, silica, asbestos). The evidence for an association between lung cancer and exposure to asphalt in paving is inconclusive.[10] The International Agency for Research on Cancer (IARC) has determined that there is inadequate evidence that asphalt alone is carcinogenic to humans.[16] Cancer risk may depend on what other materials or contaminants are present in the asphalt.

In 1977, NIOSH established a REL of 5 mg/m^3 as a 15-minute ceiling limit for asphalt fumes, measured as TP. This was intended to protect

against acute effects, including irritation of the serous membranes of the conjunctivae and the mucous membranes of the respiratory tract.[17] Since then, data have become available indicating that exposure to roofing asphalt fume condensates, raw roofing asphalt, and asphalt-based paints may pose a risk of lung cancer to exposed workers. In 1988, NIOSH recommended that asphalt fumes be considered a potential occupational carcinogen.[18] In 2000, NIOSH completed work on a comprehensive Hazard Review on asphalt that neither found nor ruled out a carcinogenic risk from asphalt fumes generated during paving operations.[10]

Asphalt fume was initially regulated by OSHA under its coal tar pitch volatile standard. Beginning in 1982, OSHA chose to interpret the coal tar pitch volatile standard to exclude asphalt fume. Although there is currently no OSHA PEL, in 1988 OSHA published a proposed rule for regulating asphalt fumes in general industry and included a PEL for asphalt fume of 5 mg/m^3, measured as TP over an 8-hour TWA. In 1992, OSHA proposed a PEL for asphalt fume of 0.2 mg/m^3 (measured as TP). The ACGIH TLV for asphalt fume is 0.5 mg/m^3 as an 8-hour TWA, measured as benzene-soluble aerosol (or equivalent method).[8] Additionally, ACGIH has assigned an A4 designation (Not Classifiable as a Human Carcinogen) to asphalt fume.

Diesel Exhaust

Diesel exhaust is a complex mixture that contains a gaseous and particulate fraction. The diesel exhaust emission will vary greatly depending upon fuel and engine type, maintenance, tuning, and exhaust gas treatment.[19,20] 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. Estimates indicate that up to 18,000 different substances from the combustion process can be adsorbed onto diesel exhaust particulate.[19] Up to 65% of the total particulate mass may be these adsorbed substances and includes compounds such as PAHs, some of which are carcinogenic.[19] More than 95% of these particles are less than 1 µm in diameter. Particles 10 µm or below are considered to be respirable particles and classified as those which have the potential to reach the lower portions of the human lung (alveolar region). Although particle sizes 10 µm and below are considered respirable, a certain portion of these particles are deposited and eliminated by the human body and its clearance mechanisms before they reach the alveolar region.[21,22]

Studies of rats and mice exposed to diesel emissions, especially the particulate portion, have confirmed an association of diesel exhaust to lung tumors.[19] Human epidemiology studies suggest an association between occupational exposure to whole diesel exhaust and lung cancer.[19,23] Additionally, workers exposed to diesel exhaust have experienced eye irritation and reversible pulmonary function changes.[19,24,25,26] Exposure criteria have been established for some of the compounds typically found in diesel exhaust (sulfur dioxide, nitrogen dioxide, aldehydes); however, there are no exposure limits to whole diesel exhaust emissions. Therefore, 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.[19] ACGIH does not have a TLV for diesel exhaust. However, diesel exhaust is listed as a chemical substance under study in their 2004 TLV/BEI booklet. The California Department of Health Services' Hazard Evaluation System and Information Service (HESIS) recommends exposure to diesel exhaust particles (measured as EC) be kept below 20 $\mu g/m^3$. This value was based on a risk assessment performed by the California Environmental Protection Agency's Office of Environmental Health Hazard Assessment that determined exposure to diesel particulate of 20 $\mu g/m^3$ over a working lifetime would create an excess lung cancer risk of one in a thousand.[27] An IARC review of diesel exhaust exposure studies found evidence for an

association between lung and bladder cancer and diesel exhaust. IARC has determined that there is *limited evidence* for the carcinogenicity in humans of diesel engine exhaust and finds that this exhaust is *probably carcinogenic to humans (Group 2A)*.[28]

CO

CO is a colorless, odorless, tasteless gas produced by incomplete burning of carbon-containing materials such as gasoline or propane fuel. The initial symptoms of CO poisoning may include headache, dizziness, drowsiness, or nausea. Symptoms may advance to vomiting, loss of consciousness, and collapse if prolonged or high exposures are encountered. If the exposure level is high, loss of consciousness may occur without other symptoms. Coma or death may occur if high exposures continue.[29,30,31,32,33,34] The display of symptoms varies widely from individual to individual, and may occur sooner in susceptible individuals such as young or aged people, people with preexisting lung or heart disease, or those living at high altitudes.

The NIOSH REL for CO is 35 ppm for full shift TWA exposure, with a ceiling limit of 200 ppm which should never be exceeded.[7] The OSHA PEL for CO is 50 ppm for an 8-hour TWA exposure.[9] ACGIH recommends an 8-hour TWA TLV of 25 ppm.[8]

Lung Cancer

Lung cancer is the leading cancer killer in the US.[35] More people die of lung cancer than of colon, breast, and prostate cancers combined. Lung cancer is fairly rare in people under the age of 40. The average age of people found to have lung cancer is 60. In 2004 there were about 173,770 new cases of lung cancer in the United States (approximately 62 of every 100,000 people).[36] It is estimated that 87% of lung cancer cases are caused by cigarette smoking; other causes include exposure to radon, asbestos, uranium, arsenic, and certain petroleum products.[35] Other work exposures, such as diesel exhaust, and non-occupational factors, such as genetic factors, may also influence lung cancer risk.

RESULTS

Industrial Hygiene

Since the truck drivers involved in this evaluation spent most of their work day inside the truck cab delivering asphalt to the paving site, NIOSH investigators decided not to have them wear air sampling pumps. This decision was primarily based on comfort, since multiple air sampling pumps would have been required to be worn by each employee. Instead, the air samples collected inside the cab of the truck on the passenger's-side seat represent, as close as possible, the driver's potential contaminant exposure.

TP/BSF

The TP and BSF air sampling results are presented in Table 1. TP concentrations ranged from 0.08-8.5 mg/m^3. The highest TP concentration was found on the heavy equipment operator on September 14, 2004. These PBZ results cannot be directly compared to the NIOSH REL for asphalt fume of 5 mg/m^3 for a 15-minute exposure since the samples were collected over the full workshift. BSF concentrations ranged from non-detectable concentrations to 0.22 mg/m^3, with the highest BSF concentration (0.22 mg/m^3) being a GA sample located near the asphalt loading area on September 15, 2004. All PBZ, 8-hour TWA results were below relevant evaluation criteria.

PACs

PAC results are not reported due to high field blank levels, suggesting possible contamination on the sample filters, and thus rendering inconclusive the results from the and air samples collected during this 2 day evaluation. See the Discussion section for more details.

OSCs

The OSC air sampling results are presented in Table 2. All sample results were below the MDC.

EC/OC

The EC/OC air sampling results are presented in Table 3. EC concentrations ranged from 3-12 $\mu g/m^3$. OC concentrations ranged from 8-291 $\mu g/m^3$. The highest concentration for EC (12 $\mu g/m^3$) was found in two areas; the cab of the front-end loader and in close proximity to the asphalt loading area.

CO

The CO air sampling results are presented in Table 4. Average CO concentrations over the entire workshift ranged from 0-6 ppm, while peak concentrations ranged from 5-44 ppm. The highest average CO concentration (6 ppm) and peak (44 ppm) were found inside the cab of truck #34177. All CO concentrations were below relevant evaluation criteria.

Medical

Employee Interviews

The NIOSH medical officer interviewed 25 of 26 Asphalt Plant 1 workers; two plant operators, one plant equipment operator, one plant maintenance laborer, 16 heavy duty truck operators (14 currently driving trucks and two currently working in the office), and five equipment mover truck operators. The average age of the workers was 42 years, ranging from 28-56 years. The average number of years working for the City of Los Angeles was 7 years, ranging from 1-29 years, and the average number of years working at their current position was 4 years, ranging from 1-10 years.

Of the 25 interviewees, two currently smoked, six had smoked in the past, three smoked an occasional cigar, and 14 had never smoked. Two interviewees had hobbies involving infrequent use of glues and solvents. When employees were asked if they had any health symptoms related to their work, four of the 25 employees reported symptoms they either felt were related to their work or were not sure of the work relatedness (sinus problems, fever blisters, neurologic disorder, and lung cancer); 21 reported no work-related health problems.

The NIOSH medical officer inquired about a list of specific health symptoms within the past month during work hours and their possible work-relatedness and these responses are provided in Table 5. Eye irritation, headache, nasal irritation, and skin rash were most commonly reported (44%, 32%, 24%, and 24%, respectively). One worker (a former smoker) reported being diagnosed with lung cancer. No employees reported being diagnosed with asthma, emphysema, chronic bronchitis, or any other non-malignant lung disease.

Document Review

The OSHA 200 and 300 logs for years 2001-2003 for Asphalt Plant 1 included 64 entries: 32 strains/sprains, 15 contusions, ten lacerations/abrasions, four insect stings, one animal bite, one crush injury, and one work stress. The OSHA 200 and 300 logs for years 2001-2003 for the City of Los Angeles Commercial Vehicle Section for Street Maintenance included 17 entries: eight sprains/strains, four lacerations, four contusions, one fracture. No OSHA recordable illnesses were entered on either set of logs.

The list of worker compensation claims from 1977 to the present for LABSS was reviewed and included eight claims from the three LABSS asphalt plants, including Asphalt Plant 1. Six of the eight claims included cancer in the injury description (two of the six claims involved one employee for the same cancer); the other two were for work-related respiratory injury. It is unclear from the information obtained if the claims were accepted due to the cancer, or to another health problem, listed in the injury description. The claims included the following

types of cancer: pancreatic (1), lung (2), skin (1), and thyroid (1).

The City Personnel Department compared use of sick leave between City of Los Angeles asphalt plant workers (n=25) to non-asphalt plant workers (n=30) during the first 10 months of 2004. They found asphalt workers had 89 fewer overall sick hours reported.

Work Practices and PPE

Truck operators have the potential for dust and asphalt fume exposure when loading their truck with hot asphalt, particularly if their cab windows are down. Each driver loads and transports an average of 4-5 loads of hot asphalt per day, and collects an equivalent number of loads of old asphalt or concrete grindings to haul and dump at a recycling location. They also have a potential dust exposure when grindings (the top two inches of material scraped off of streets being repaired) are dropped into their truck beds via a conveyor belt system. Truck operators reported that they must keep their cab window rolled down when hot asphalt or grindings are being loaded to hear instructions from either the plant tower operator (at the asphalt plant) or the grinding crew (at the paving site); resulting in dust and fumes entering the cab. Attempts are made to minimize the dust at the paving sites by using wet grinding techniques and grinding machinery that has a ventilation system. Plant operators and plant maintenance have the potential for dust and asphalt fume exposure during maintenance and repair of equipment at the plant.

Workers reported that standard PPE included the following: safety shoes, hard hats, coveralls, face shields, hearing protection, leather gloves. Plant operators and maintenance laborers reported wearing filtering-facepiece particulate respirators when sweeping or blowing dust, when close to the mixing platform, during maintenance, and in required locations. The plant equipment operator reported wearing a similar respirator for much of this work. Heavy duty truck operators were not required to wear respirators, although some truck operators expressed a desire to have the option to wear a respirator during dusty conditions. Some workers also expressed a desire to have a shower area to clean up after work.

Although this HHE did not include an evaluation of the grinding crews, interviewed employees expressed concern over their job exposures. Grinding crew workers are potentially exposed to concrete and asphalt dust as it is being ground up from the street and may not have appropriate protection. Most, but not all, grinders wear particulate-filtering respirators; however, some grinding crew employees wearing respirators were observed by one NIOSH investigator to have facial hair interfering with the seal. Information obtained from employees indicated that respirator fit testing is not performed.

DISCUSSION

Industrial Hygiene

Air sampling for TP/BSF indicated low exposure levels for most of the samples collected. One TP concentration taken on the heavy equipment operator approached the ACGIH TLV of 10 mg/m^3. This employee was moving aggregate with a front-end loader; an activity which is capable of creating very dusty conditions. The small amount of BSP present in the sample obtained from the front-end loader (less than 1% of the TP), suggests that this exposure resulted from aggregate dust and not from asphalt fume.

Air sampling for EC/OC indicated that the ratio of EC to TC (EC + OC) was low for a majority of the samples collected (suggesting that diesel exhaust was not a major contribution to the TC). Not surprisingly, the highest EC results (12 $\mu g/m^3$ [front-end loader cab and asphalt loading area]) and EC/TC ratios (50% [plant exit] and 63% [plant entrance]) were located in areas that would be expected to have higher diesel exhaust concentrations. Diesel trucks move through the plant entrance/exit and the asphalt loading area throughout the day.

In addition to the air samples collected during this survey, field blanks for each type of sample media were submitted to the laboratory for analysis. Field blanks are unused samples taken into the field and then submitted along with the actual air samples which are collected. Any results from the field blanks are used to adjust the air sample results (a deduction in amount of compound, resulting in a reduced concentration). Thus, field blanks provide valuable information into potential contamination from shipping, handling, and storage of samples. Media blanks, which are similar to field blanks but are not taken into the field, were also submitted to the laboratory. Media blanks provide an indication of what background chemical compounds may be on the sampling media.

The field blanks submitted for PAC analysis from the first day of sampling unexpectedly had higher levels (µg/sample) than most of the air samples collected during that day. However, the field blanks for the second day of sampling did not indicate levels higher than the air samples. The media blanks submitted did not contain PACs above the LOQ. We cannot explain these results, and because of the uncertainty of the PAC values, we have not reported the PAC air sampling results. However, assuming a "worse case" scenario (no field blank correction of the overall air sampling results), the PAC concentrations are similar to those found during previous NIOSH HHEs involving asphalt paving crews.[37]

Medical

The majority of interviewed workers (21 of 25) reported that they had no work-related health symptoms. The most commonly reported symptom that employees felt to be work related was eye irritation, followed by headache. No employees reported having a diagnosis of non-malignant lung disease. Two employees reported experiencing chest tightness at work. Acute health effects known to occur from exposure to asphalt fumes include eye, nasal, and throat irritation, which are transient. These symptoms have been seen in workers exposed to asphalt fumes at geometric mean concentrations generally below 1 mg/m^3 TP and 0.3 mg/m^3 BSP or carbon disulfide-soluble particulates calculated as full-shift TWA.[10] Headache and coughing have also been associated with asphalt fume exposure. Skin irritation, pruritis (itching), and rashes have been reported. There is also evidence of acute lower respiratory tract symptoms (i.e., coughing, wheezing, and shortness of breath) and pulmonary function changes associated with asphalt fume exposure; however, further studies are needed to determine the strength of this relationship.[10]

A review of workers' compensation claims data provided by management indicated that, in the past 27 years, five asphalt exposed employees have made workers' compensation claims for cancers (among other health problems); two for lung cancer, one for pancreatic cancer, one for skin cancer, and one for thyroid cancer. One current Asphalt Plant 1 employee, with a history of prior cigarette smoking, has been diagnosed with lung cancer. At this time, experts have determined that there is inadequate evidence that asphalt alone is carcinogenic to humans.[38] Cancer risk may depend on what other materials or contaminants are present in the asphalt. Other work exposures, such as diesel exhaust, and non-occupational exposures, such as cigarette smoking, diet, and genetic factors, may also influence cancer risk.

Work Practices and PPE

The LABSS has a written respiratory protection program in place in accordance with OSHA 29 CFR 1910.134 which covered all of their facilities. However, we were not provided any site specific respiratory protection program applicable for Asphalt Plant 1 which outlined the locations and work activities which required respiratory protection. We also did not review any Asphalt Plant 1 program for workers who may choose to wear a respirator voluntarily. In addition, we did observe and examine what appeared to be old emergency use respirators (self-contained breathing apparatus) which were not properly maintained.

CONCLUSIONS

1. There does not appear to be a health hazard from exposure to asphalt fume or diesel exhaust at this facility. However, transient eye, nasal, and throat irritation (symptoms which are consistent with exposure to asphalt fumes and particulates) were reported by some workers.

2. Exposure levels to diesel exhaust and asphalt fume measured during this survey are consistent with results from other asphalt surveys conducted by NIOSH investigators.

3. Although an overall written respiratory protection program exists for all LABSS facilities, we did not review a site specific program applicable for Asphalt Plant 1 which outlined the locations and work activities which required respiratory protection. We also did not review a voluntary use respirator program for workers.

RECOMMENDATIONS

The following recommendations are based on the findings of this investigation and offered to improve the safety and health of employees working with materials used in the operations discussed in this report.

1. Repair any cracks, tears, or other damaged duct-work inside the ventilated asphalt loading area at Asphalt Plant 1.

2. Keep windows closed on trucks receiving asphalt. To communicate with truck drivers, use visual and/or in-cab auditory signals.

3. Since respirators are used (both required and voluntary), LABSS should ensure that there are respirator requirements in place which are specific to Asphalt Plant 1 and follow the California Code of Regulations, General Industry Safety Order 5144.

4. Dispose of all outdated gloves and respirators and, where necessary, replace with the most appropriate type.

5. Appropriate hearing protection signs should be placed in Asphalt Plant 1 areas where hearing protection is required.

6. Employees with ongoing health concerns should be evaluated by their personal physician. Those employees found to have potential work-related health effects should be referred to a physician board certified in occupational medicine (e.g., at the University of California in Los Angeles Center for Occupational and Environmental Health).

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TABLES

Industrial Hygiene

Abbreviations and Symbols Used in the Following Tables

mg/m^3	=	milligrams per cubic meter of air
$\mu g/m^3$	=	micrograms per cubic meter of air
ppm	=	parts per million
PBZ	=	personal breathing zone sample
GA	=	general area sample
TP/BSF	=	total particulate/benzene-soluble fraction
PAC	=	polycyclic aromatic compound
EC	=	elemental carbon
OC	=	organic carbon
TC	=	total carbon (EC + OC)
EC/TC	=	ratio of elemental carbon to total carbon
trace	=	the substance was detected in the air (present above the minimum detectable concentration), but at a concentration below what is considered reliably quantifiable (the minimum quantifiable concentration).
ND	=	the substance was not detected in the air at a concentration at or above the minimum detectable concentration.
MDC	=	minimum detectable concentration
MQC	=	minimum quantifiable concentration
OSHA PEL	=	Occupational Safety and Health Administration, Permissible Exposure Limit
NIOSH REL	=	National Institute for Occupational Safety and Health, Recommended Exposure Limit
ACGIH TLV	=	American Conference of Governmental Industrial Hygienists, Threshold Limit Value
*	=	Reduced sampling time due to sampling pump failure
‡	=	The NIOSH REL is 5 mg/m^3, measured as TP for a 15-minute exposure. All air samples were collected over a full work shift and thus cannot be directly compared to the REL.
N	=	number

Table 1: Air Sampling for Total Particulate and the Benzene-soluble Fraction of Collected Particulate
City of Los Angeles, Bureau of Street Services, Los Angeles, California
HETA 2004-0184-2965

Job/Location	Sample #	Sample Time (military)	Volume (liters)	Concentration, milligrams per cubic meter(mg/m^3)	
				Total Particulate	Benzene-soluble Fraction
		September 14, 2004			
PBZ – Plant Operator	TP/BSF – 004	0518 – 1251	903	2.77	trace
PBZ – Maintenance/Laborer	TP/BSF – 003	0513 – 1315	947	0.86	trace
PBZ – Heavy Equipment Operator	TP/BSF – 002	0544 – 1355	990	8.48	0.08
GA – Inside Cab of Truck #34132	TP/BSF – 008	0634 – 1341	858	0.09	trace
GA – Inside Cab of Truck #34163	TP/BSF – 001	0610 – 1348	898	0.08	trace
GA – Inside Cab of Truck #34171	TP/BSF – 010		Sampling pump did not operate		
GA – Inside Cab of Truck #34173	TP/BSF – 009	0637 – 1442	951	0.12	trace
GA – Inside Cab of Truck #34177	TP/BSF – 007	0720 – 1348	787	0.14	trace
GA – Inside Cab of Truck #34179	TP/BSF – 006	0705 – 1635	1144	0.18	trace
		September 15, 2004			
PBZ – Plant Operator	TP/BSF – 013	0500 – 1247	911	0.21	ND
PBZ – Plant Operator Assistant	TP/BSF – 019	0648 – 1220*	658	0.29	trace
PBZ – Maintenance/Laborer	TP/BSF – 011	0505 – 1308	947	0.21	trace
PBZ – Heavy Equipment Operator	TP/BSF – 017	0542 – 1348	907	0.75	trace
GA – Inside Cab of Truck #23696	TP/BSF – 012	0615 – 1455	1020	0.28	0.06
GA – Inside Cab of Truck #23883	TP/BSF – 015	0630 – 1408	881	0.15	ND
GA – Inside Cab of Truck #34161	TP/BSF – 020	0615 – 1455	1044	0.15	trace
GA – Inside Cab of Truck #34179	TP/BSF – 018	0602 – 1503	1037	0.18	trace
GA – Asphalt Loading Area	TP/BSF – 016	0629 – 1415	936	0.36	0.22
GA – Administration Building	TP/BSF – 014	0724 – 1441	873	0.13	ND
Minimum Detectable Concentration (MDC)				0.02	0.02
Minimum Quantifiable Concentration (MQC)				0.05	0.05
Evaluation Criteria		OSHA Permissible Exposure Limit		None	None
		NIOSH Recommended Exposure Limit		5‡	None
		ACGIH Threshold Limit Value		None	0.5

ND = Concentration is below the MDC
Trace = Concentration between the MDC and MQC
* = Reduced sampling time due to sampling pump failure
‡ = The NIOSH REL is 5 mg/m^3, measured as TP for a 15-minute exposure. All air samples were collected over a full work shift and thus cannot be directly compared to the REL.

Table 2: Air Sampling for Total Organic Sulfur Compounds
City of Los Angeles, Bureau of Street Services, Los Angeles, California
HETA 2004-0184-2965

Job/Location	Sample #	Sample Time (military)	Volume (liters)	Concentration (µg/m^3) Total Organic Sulfur
		September 14, 2004		
PBZ – Plant Operator	PAC – 001	0518 – 1251	472	ND
PBZ – Maintenance/Laborer	PAC – 002	0513 – 1208*	399	ND
PBZ – Heavy Equipment Operator	PAC – 009	0544 – 1355	479	ND
GA – Inside Cab of Truck #34132	PAC – 008	0634 – 1341	407	ND
GA – Inside Cab of Truck #34163	PAC – 005	0610 – 1348	451	ND
GA – Inside Cab of Truck #34171	PAC – 006	0630 – 1450	484	ND
GA – Inside Cab of Truck #34173	PAC – 004	0637 – 1442	499	ND
GA – Inside Cab of Truck #34177	PAC – 003	0720 – 1348	389	ND
GA – Inside Cab of Truck #34179	PAC – 007	0705 – 1635	592	ND
		September 15, 2004		
PBZ – Plant Operator	PAC – 019	0500 – 1247	483	ND
PBZ – Plant Operator Assistant	PAC – 017	0648 – 1405	441	ND
PBZ – Maintenance/Laborer	PAC – 015	0505 – 1308	476	ND
PBZ – Heavy Equipment Operator	PAC – 018	0542 – 1348	523	ND
GA – Inside Cab of Truck #23696	PAC – 012	0615 – 1455	515	ND
GA – Inside Cab of Truck #23883	PAC – 013	0630 – 1408	446	ND
GA – Inside Cab of Truck #34161	PAC – 020	0615 – 1455	485	ND
GA – Inside Cab of Truck #34179	PAC – 016	0602 – 1503	543	ND
GA – Asphalt Loading Area	PAC – 014	0629 – 1415	483	ND
GA – Administration Building	PAC – 021	0724 – 0935*	136	ND
Minimum Detectable Concentration (MDC)				12
Minimum Quantifiable Concentration (MQC)				38
Evaluation Criteria			OSHA Permissible Exposure Limit	None
			NIOSH Recommended Exposure	None
			ACGIH Threshold Limit Value	None

µg/m^3 = micrograms per cubic meter
ND = Not detected (below the MDC)
* = Reduced sampling time due to sampling pump failure

Table 3: Air Sampling for Diesel Exhaust (Organic Carbon and Elemental Carbon)
City of Los Angeles, Bureau of Street Services, Los Angeles, California
HETA 2004-0184-2965

Job/Location	Sample #	Sample Time (military)	Volume (liters)	Concentration (µg/m^3)		
				EC	OC	EC/TC (%)
September 14, 2004						
PBZ – Plant Operator Assistant	EC/OC – 004	0725 – 1435	856	5	64	5/69 (7%)
GA – Inside Cab of Truck #34132	EC/OC – 008	0634 – 1342	841	5	35	5/40 (13%)
GA – Inside Cab of Truck #34163	EC/OC – 005	0610 – 1348	909	7	37	7/44 (16%)
GA – Inside Cab of Truck #34171	EC/OC – 009	0630 – 1450	786	8	56	8/64 (13%)
GA – Inside Cab of Truck #34173	EC/OC – 007	0637 – 1442	958	5	57	5/62 (8%)
GA – Inside Cab of Truck #34177	EC/OC – 010	0720 – 1348	771	6	53	6/59 (10%)
GA – Inside Cab of Truck #34179	EC/OC – 001	0705 – 1635	1147	6	38	6/44 (14%)
GA – Northside Plant Entrance	EC/OC – 006	0824 – 1458	773	7	24	7/31 (23%)
GA – Outside Control Room Area, ground level	EC/OC – 002	0835 – 1505	787	3	24	3/27 (11%)
GA – Eastside Plant Exit	EC/OC – 003	0827 - 1500	772	5	17	5/22 (23%)
September 15, 2004						
GA – Inside Front-end Loader Cab	EC/OC – 014	0552 – 1348	935	12	35	12/47 (26%)
GA – Inside Cab of Truck #23696	EC/OC – 019	0615 – 1455	1031	8	52	8/60 (13%)
GA – Inside Cab of Truck #23883	EC/OC – 018	0630 – 1408	890	5	37	5/42 (12%)
GA – Inside Cab of Truck #34161	EC/OC – 011	0615 – 1455	1044	4	47	4/51 (8%)
GA – Inside Cab of Truck #34179	EC/OC – 016	0602 – 1503	1072	11	56	11/67 (16%)
GA – Asphalt Loading Area	EC/OC – 013	0629 – 1415	902	12	291	12/303 (4%)
GA – Northside Plant Entrance	EC/OC – 020	0509 – 1324	971	10	16	10/26 (39%)
GA – Eastside Plant Exit	EC/OC – 017	0520 – 1333	966	4	8	4/12 (33%)
GA – Administration Building	EC/OC – 012	0724 – 1441	868	3	12	3/15 (20%)
Minimum Detectable Concentration				1.7	0.17	NA
Minimum Quantifiable Concentration				6.8	0.43	NA
Evaluation Criteria		OSHA Permissive Exposure Limit		None		NA
		NIOSH Recommended Exposure Limit		None		NA
		ACGIH Threshold Limit Value		None		NA

µg/m^3 = micrograms per cubic meter
NA = not applicable
EC = Elemental carbon
OC = Organic carbon
TC = Total carbon

Table 4. Real-time Monitoring for Carbon monoxide
City of Los Angeles, Bureau of Street Services, Los Angeles, California
HETA 2004-0184-2965

Job/Location	Sample Time (military)	Concentration (ppm)	
		Average	Peak
	September 14, 2004		
GA – Inside Cab of Truck #34173	0637 – 1439	1	8
GA – Inside Cab of Truck #34177	0721 – 1407	6	44
GA – Northside Plant Entrance	0825 – 1457	1	39
GA – Eastside Plant Exit	1020 – 1458	0	9
	September 15, 2004		
GA – Inside Cab of Truck #34179	0602 – 1503	1	11
GA – Northside Plant Entrance	0510 – 1325	0	5
GA – Eastside Plant Exit	0517 – 1330	0	5
GA – Administration Building	0721 – 1440	1	6
Evaluation Criteria	OSHA Permissible Exposure Limit	50	None
	NIOSH Recommended Exposure Limit	35	200
	ACGIH Threshold Limit Value	25	None

ppm = parts per million

Table 5. Worker Health Symptoms
City of Los Angeles, Bureau of Street Services, Los Angeles, California
HETA 2004-0184-2965

Symptom	Number (#) of workers with the symptom (%) N=25	# of workers that think symptom is work-related (%) N=25	# of workers unsure of symptom cause (%) N=25	# of workers that think symptom is not related to work (%) N=25
Eye irritation	11 (44%)	5 (20%)	4 (16%)	2 (8%)
Headache	8 (32%)	2 (8%)	3 (12%)	3 (12%)
Skin rash	6 (24%)	0	4 (16%)	2 (8%)
Nasal irritation	6 (24%)	1 (4%)	3 (12%)	2 (8%)
Throat irritation	3 (12%)	0	2 (8%)	1 (4%)
Cough	3 (12%)	1 (4%)	1 (4%)	1 (4%)
Cough with phlegm	3 (12%)	1 (4%)	1 (4%)	1 (4%)
Chest tightness	2 (8%)	1 (4%)	1 (4%)	0
Wheeze	0	0	0	0
Shortness of breath	0	0	0	0

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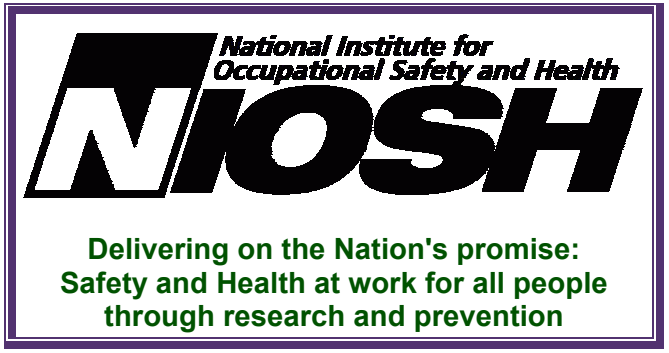

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