

## ASPHALT

### ASPHALT FUME CHARACTERIZATION AND HAZARD IDENTIFICATION

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**PURPOSE:** Identify specific compounds or compound classes in asphalt fumes that may cause irritation or genotoxicity.

**RESEARCH SUMMARY:** This research will be integral to development of sampling and analytical methods used to assess exposures to asphalt fumes and specific irritants and genotoxins. Laboratory research will be useful in designing better worker exposure protocols, identifying specific biomarkers to assess a worker's true exposure, and designing animal studies to evaluate physiological and toxicological effects associated with exposure.

Specifically, research will focus on the following tasks:

- Fractionate, analyze, and bioassay the biologically active asphalt fume fractions from an earlier study to identify specific genotoxins that may be responsible for observed tumors.
- Conduct research for the Federal Highway Administration to determine if the addition of crumb-rubber to asphalt mixtures results in more-hazardous asphalt fumes.
- Test paving asphalt fume samples for mutagenicity under an interagency agreement with EPA.
- Characterize the chemistry of paving and roofing asphalt fume samples.
- Consult on the chemical characterization and assessment of the asphalt fumes to which animals will be exposed to investigate physiological and toxic responses.
  - Collaborate on the development of sampling and analytical methods for the benzene-soluble fraction and total particulates.
- Collaborate on ways to foster better communication regarding asphalt fume research.
- Collaborate with industry researchers to evaluate high-performance chromatography (HPLC)/fluorescence methods for the determination of polycyclic aromatic hydrocarbons (PAH's) in asphalt fumes and compare results with results using gas chromatography/mass spectrometry (GC/MS) techniques.

**KEYWORDS:** Asphalt, hazard identification, analytical methods

#### RECENT CITATIONS:

Butler, M.A., G. Burr, D. Dankovic, R.A. Lunsford, A. Miller, M. Nguyen, L. Olsen, D. Sharpnack, J. Snawder, L. Stayner, M. Haring Sweeney, A. Teass, J. Wess, and R. Zumwalde. 2001. Health effects of occupational exposure to asphalt. NIOSH Hazard Review. DHHS (NIOSH) Pub. 2001-110.

Jaycox, L.B., and L.D. Olsen. 2000. Determination of total sulfur compounds and benzothiazole in asphalt fume samples by gas chromatography with sulfur chemiluminescence detection. *Applied Occupational and Environmental Hygiene*, v. 15, no. 9, pp. 695-704.

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# MOLECULAR MARKERS OF ASPHALT FUME EXPOSURE

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**PURPOSE:** Develop state-of-the-art analytical and bioanalytical methods to study the adverse health effects of asphalt fume exposures.

**RESEARCH SUMMARY:** Millions of tons of asphalt are produced and used every year in the paving and roofing industries. It has been estimated that crude asphalt contains the most widely distributed class of potent carcinogens present in the human environment. Exposure to these mixtures may pose a health risk to workers; however, specific adverse effects have not been established. In particular, the relationship between exposure and DNA damage is not clear. Also, there is a concern about long-term health effects following chronic exposure.

A sensitive, selective, and reliable analytical method has been developed and validated for characterization of asphalt fumes generated under conditions that simulate road paving sites. The new method could be used as an effective tool to study the adverse health effects of workers exposed to hazardous mixtures.

Polycyclic aromatic hydrocarbons (PAH's) contained in asphalt are an important class of chemical hazards. These compounds or their metabolites can interact with DNA, resulting in covalent bonding between chemicals and biological macromolecules and consequent damage to DNA. In this study, female Sprague-Dawley rats and B6C3F1 mice were exposed to asphalt fumes in a whole-body inhalation chamber. A new bioanalytical method was developed to characterize DNA adducts and PAH metabolites. This method has a wide variety of applications in detecting molecular markers during exposure to a number of different agents.

The information obtained from these studies may assist risk assessment and the development of prevention strategies for people exposed to such mixtures in the workplace.

**KEYWORDS:** Asphalt fume exposure, biomarkers, analytical and bioanalytical methods

## RECENT CITATIONS:

Wang, J., D.M. Lewis, V. Castranova, D.G. Frazer, T. Goldsmith, S. Tomblyn, J. Simpson, S. Stone, A. Afshari, and P.D. Siegel. 2001. Characterization of asphalt fume composition under simulated road paving conditions by GC-MS and microflow LC-Q-TOF MS. *Analytical Chemistry*, v. 73, no.15, pp. 3691-3700.

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# ASPHALT FUMES: INFLAMMATORY EFFECTS AND PULMONARY INJURY

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**PURPOSE:** Investigate the effects of asphalt fumes on pulmonary irritation, inflammation, airway reactivity, and lung injury.

**RESEARCH SUMMARY:** A 1983 NIOSH report showed that at least 500,000 workers were exposed to asphalt fumes in the United States. Exposure to asphalt fumes during road paving operations has been associated with airway irritation and airway hyperreactivity in some pavers.

It is known that the fumes generated from both paving and roofing asphalts are very complex mixtures, containing particulates and various organic compounds, such as polycyclic aromatic compounds (PAH's). Exposures to mixed materials, such as asphalt fumes, may result in greater pulmonary injury than exposure to a single agent.

In this project, the effects of road paving asphalt fumes on airway irritation, pulmonary inflammation, airway reactivity, and lung damage will be monitored to assess the inflammatory potential of asphalt fumes and oxidative stress in the lungs. Pulmonary injury will be evaluated by measuring oxidant generation, inflammatory cytokine secretion, and metabolic activities in the lung. Airway irritation will be monitored by histological evaluation of the nasal cavity. Airway reactivity will be evaluated by measuring pulmonary function. These studies will characterize in detail the major components of cytochrome 450, cytochrome 1A1, and cytochrome 2B1 isozyme levels, and metabolic activities of these isozymes. The results of these studies should aid in better understanding of the mechanism of potential toxicity induced by asphalt fumes and the potential health hazards associated with exposure to asphalt fumes.

**KEYWORDS:** Asphalt, hazards, mixed exposures

## RECENT CITATIONS:

Gamble, J.F., M.J. Nicolich, N.J. Barone, and W.J. Vincent. 1999. Exposure-response of asphalt fumes with changes in pulmonary function and symptoms. *Scandinavian Journal of Work and Environmental Health*, v. 25, pp. 186-206.

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Ma, J.Y., M.W. Barger, A.J. Kriech, and V. Castranova. 2000. Effects of asphalt fume condensate exposure on acute pulmonary responses. *Archives of Toxicology*, v. 74, pp. 452-459.

Micillino, J.C., C. Coulais, S. Binet, M.C. Bottin, G. Keith, D. Moulin, and B.H. Rihn. 2002. Lack of genotoxicity of bitumen fumes in transgenic mouse lung. *Toxicology*, v. 170, pp. 11-20.

# ASSESSMENT OF ASPHALT FUME EXPOSURE FROM ROOFING KETTLES

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**PURPOSE:** Evaluate existing engineering controls of fume exposures to roofing kettle operators and redesign those controls to reduce worker exposures.

**RESEARCH SUMMARY:** Because of extreme asphalt temperatures during the roofing process, roofers may be at the highest risk of exposure to asphalt fumes of all industry or trade workers. In 1990, an estimated 46,000 roofing workers in the United States were exposed, most of them employed by small contractors (about 90% of roofing contractors have fewer than 20 employees) who do not have access to current technology for controlling exposures. Epidemiological data indicate excess mortality from cancer of the respiratory system, digestive system, and urinary system. Health effects from exposure to asphalt fumes include irritation of the respiratory tract and lung diseases such as bronchitis, emphysema, and asthma.

The evaluation and development of practical controls for roofing kettle emissions could significantly reduce worker exposure to asphalt fumes. This will be accomplished through a combination of isolation and local ventilation techniques, changes in work processes, and industry and labor partnerships. Specific recommendations will be based on initial surveys and quantitative analyses of exposure levels. The exposure of roofing kettle operators to asphalt fumes will be evaluated, the efficiency of existing exposure controls will be examined, and recommendations will be provided as necessary. To date, literature searches, discussions with roofing kettle manufacturers and operators, and walk-through surveys have provided pertinent information on asphalt fume generation and control. In-depth studies have been conducted using conventional and real-time air sampling techniques to evaluate worker exposure and the effectiveness of controls.

A pilot study demonstrated a statistically significant reduction of from 55% to 95% in the benzene-soluble fraction of total particulates in area and personal exposures when a low-fuming, built-up roofing asphalt (BURA) was used instead of a standard BURA. Low-fuming BURA contains a blend of up to 1% polymers that form a crust that reduces the release of fumes from asphalt.

Four field surveys were conducted to study whether similar reductions could be seen in the workplace. Personal breathing zone and area air samples were collected from both low-fuming asphalt and standard BURA and analyzed for total particulates, benzene-soluble fraction, and polycyclic aromatic compounds. Results of these surveys showed that when low-fuming BURA was used, kettle operators' mean exposures were reduced by 75%, 85%, and



77%, respectively, and roof-level workers exposures were reduced by 28%, 24%, and 27%, respectively.

**KEYWORDS:** Asphalt, small business, engineering controls, roofers

## RECENT CITATIONS:

Franzen, M.R., and D.C. Trumbore. 2000. Reduction of asphalt fumes in roofing kettles. *Environmental Science and Technology*, v. 34, pp. 2582-2586.

# CONTROL OF EXPOSURE DURING APPLICATION OF ASPHALT ROOFING MATERIALS

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**PURPOSE:** Develop a technical document that addresses work practices and methods for reducing exposure to asphalt fumes and other potential hazards during the application of hot asphalt to roofs.

**RESEARCH SUMMARY:** Approximately 46,000 workers are involved in the application of hot asphalt to roofs. Exposures have been hypothesized to be related to increased incidence of some cancers, as well as lung and skin irritation. A draft document produced jointly by the Asphalt Roofing Manufacturers' Association (ARMA), the National Roofing Contractors' Association (NRCA), the Asphalt Institute (AI), and the United Union of Roofers, Waterproofers, and Allied Workers was presented to NIOSH for review and further development in a collaborative effort.

The document will describe methods to control and reduce asphalt exposure among workers in the asphalt roofing industry. The intended audience is plant managers, safety and health personnel, and engineers in industry and government. Dissemination of the document will be through trade unions, trade associations, the Internet, and other means appropriate for this population.

**KEYWORDS:** Work practices, asphalt, hazards, roofers

## RECENT CITATIONS:

National Institute for Occupational Safety and Health. 2001. Health effects of occupational exposure to asphalt. NIOSH Hazard Review. DHHS (NIOSH) Pub. 2001-110.

National Institute for Occupational Safety and Health. 2001. Asphalt fume exposure during the manufacture of asphalt roofing products: Current practices for reducing exposures. DHHS (NIOSH) Pub. 2001-127.

Gamble, J.F., M.J. Nicolich, N.J. Barone, and J. Vincent. 1999. Exposure-response of asphalt fumes with changes in pulmonary function and symptoms. *Scandinavian Journal of Work and Environmental Health*, v. 25, no. 3, pp. 186-206.

# HEALTH EFFECTS OF ASPHALT EXPOSURE: DEVELOPMENT OF A REL

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**PURPOSE:** Acquire the documentation and develop a recommended standard that includes an occupational exposure limit for asphalt based on a recently published NIOSH Hazard Review document on asphalt.

**RESEARCH SUMMARY:** Nationwide, 300,000 workers are involved in the application of asphalt paving materials, and 46,000 workers apply hot roofing materials. These workers include laborers, operating engineers, roofers, and waterproofers.

The information published in a recent NIOSH Hazard Review will be used along with medical and exposure data collected by NIOSH during an evaluation of paving workers to develop a recommended standard for asphalt. The standard or criteria document will include recommendations for medical surveillance and exposure monitoring, the use of personal protective equipment and engineering controls, work practices, and the basis for a Recommended Exposure Limit (REL).

Compliance with the REL should reduce risks of lung cancer and acute and chronic respiratory effects in workers exposed to asphalt during road paving, the manufacture of asphalt products, and the application of hot asphalt roofing and asphalt-containing waterproofing materials.

**KEYWORDS:** Occupational exposure limits, asphalt, cancer

## RECENT CITATIONS:

National Institute for Occupational Safety and Health. 2001. Health effects of occupational exposure to asphalt. NIOSH Hazard Review. DHHS (NIOSH) Pub. 2001-110.

Miller, A.K., and G.A. Burr. 1998. Health hazard evaluation report: Bardon-Trimount, Stoughton, Massachusetts. NIOSH HETA No. 97-0232-2674.

# CONCISE INTERNATIONAL CHEMICAL ASSESSMENT ON ASPHALT EXPOSURE

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**PURPOSE:** Develop a Concise International Chemical Assessment Document (CICAD) in partnership with the World Health Organization concerning asphalt fumes from paving, roofing, manufacturing, and other processes.

**RESEARCH SUMMARY:** In the United States, over 300,000 workers are employed in the asphalt paving and hot-mix industries, 53,000 workers are employed in roofing, and 1,500 are employed in producing asphalt-based roofing materials. Asphalt fumes are a complex mixture of petroleum by-products. The composition of this mixture and its resultant toxicity is dependent on many factors, including the engineering controls used during various stages of asphalt application. Limited toxicologic data suggest that asphalt fumes composed of polycyclic aromatic hydrocarbons are carcinogenic in animals.

A Concise International Chemical Assessment Document (CICAD) on asphalt exposure will be developed in partnership with the World Health Organization (WHO). CICAD's are concise documents that provide summaries of the relevant scientific information concerning the potential effects of chemicals on human health and the environment. The proposed CICAD will characterize exposures to asphalt fumes and describe their potential effects on human health in both the workplace and the environment. It will be based on information generated by NIOSH research and partnership efforts with the asphalt industry and representatives of workers in that industry. This information has been published, in part, in NIOSH documents on controlling exposure to asphalt fumes and in a Health Hazard Review on the health effects of occupational exposure to asphalt. The project would involve limited searches in additional literature on the environmental transport, distribution, and transportation of asphalt and asphalt by-products. The available information would be compiled and reviewed and developed into a CICAD and disseminated worldwide through our partnership with WHO.

In addition to being an international resource document, this CICAD could serve as concise publication for industrial hygienists in the United States who are involved with construction workers who may be exposed to asphalt fumes.

**KEYWORDS:** Polycyclic aromatic hydrocarbons, occupational exposure limits

## RECENT CITATIONS:

National Institute for Occupational Safety and Health. 2001. Health effects of occupational exposure to asphalt. NIOSH Hazard Review. DHHS (NIOSH) Pub. 2001-110.