

Protocol

**Assessment of Occupational Exposure to PAHs
in
Coal Tar Sealant Applications**

Centers for Disease Control and Prevention

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Protocol Summary

This study will evaluate the levels of occupational chemical exposure among workers who are using coal tar-based pavement sealants. Coal tar is sometimes used as a base material for blacktop pavement sealants, accounting for as much as 35% of the formulation in some of these products. Coal tar is a by-product of the production of coke, which is needed for steel production. Coal tar pitch volatiles are a mixture of chemicals which can evaporate into air from products containing coal tar, including coal tar pavement sealants. These coal tar pitch volatiles contain several chemicals known as polycyclic aromatic hydrocarbons (PAHs). The focus of this study is the assessment of occupational exposure to PAHs among coal tar sealant workers. This study will provide data regarding levels of exposure to airborne chemicals that will be compared to current NIOSH Recommended Exposure Limits (RELs) for coal tar pitch volatiles, and will report results for specific PAH chemicals using NIOSH analytical methods. PAHs will be measured in dermal wipe samples and PAH metabolites will be measured in biological samples collected from workers, to characterize levels present in this workforce.

INTRODUCTION

Coal tar is a complex mixture of chemicals known to include a variety of polycyclic aromatic hydrocarbons, some of which are listed as carcinogens, probable carcinogens, or possible carcinogens by the International Agency for Research on Cancer (IARC)[1, 2]. IARC has classified coal tar pitch as carcinogenic in humans [3]. The Occupational Safety and Health Administration (OSHA) defines “coal tar pitch volatiles” as the fused polycyclic hydrocarbons that volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter. This includes polycyclic aromatic hydrocarbons such as anthracene, benzo(a)pyrene (BaP), phenanthrene, chrysene, pyrene, etc. [4]. NIOSH also considers coal tar products to be potential occupational carcinogens because they contain PAHs classified as carcinogens by IARC [5, 6].

Refined coal tar-based sealants (RTS) are applied as a protective coating for blacktop parking lot pavement. RTS are predominately used east of the continental divide, since RTS are produced from a by-product of the production of coke, and coke ovens are concentrated in the eastern part of the US. RTS pavement sealants are manufactured as an emulsion using refined [metallurgical] coal tar grade RT-12 (ASTM D490-92 2011), a particular grade obtained from the crude coal tar residuum produced in the production of coke. West of the continental divide, petroleum-based sealants, derived from a bottom residuum byproduct of the distillation of crude oil, and commonly known as asphalt sealants (AS), are most often used. RTS are considered by some to be desirable due to their ability to withstand spills of petroleum products like gas and oil. Compared with RTS, asphalt sealants have been thought to break down more readily in petroleum spills, and not last quite as long.

Asphalt sealants have been reported to contain PAH levels lower than RTS [7]. Both sealant product types can be applied with similar techniques. Application methods for pavement sealants include: spraying from a truck equipped for this purpose; manual application with a spray wand connected to a tank, and/or pouring from buckets and spreading manually.

United States Geological Survey (USGS) researchers have identified RTS sealed parking lots as a source of PAHs in storm water runoff [7, 8] and settled household dust found in apartments adjacent to these lots [9]. The USGS has also performed environmental air sampling immediately after completion of pavement seal coating, finding measurable concentrations of various PAHs including some of the same chemicals listed in the occupational classification “coal tar pitch volatiles” [10]. In addition to the potential for airborne exposure, handling and application of sealants has potential for dermal exposure to sealant chemicals. These circumstances indicate the need for evaluation of occupational exposure levels for workers applying coal tar sealants. An unpublished industry report was identified which includes results of air sampling for PAHs during sealant application [11]. Review of the literature indicates that some very limited measurements have been made of occupational airborne levels of PAHs during coal tar chip sealing, a roadbuilding process which currently uses an asphalt-based binder, but which historically did use a coal tar-based binder in some locations [12]. To the best of our knowledge no occupational research on PAH exposure associated with application of RTS to pavement is available in the published scientific literature. This study will help fill that gap.

Occupational airborne exposures to mixtures containing coal tar have historically been assessed by measuring the mixture of chemicals known as coal tar pitch volatiles in workplace air. The OSHA Permissible Exposure Limit (PEL) for coal tar pitch volatiles is 0.2 mg/m³, measured as a full-shift time-weighted-average (TWA), while the NIOSH Recommended Exposure Limit (REL) is more conservative at 0.1 mg/m³. In addition to the full-shift REL applicable to the mixture of coal tar pitch volatiles, naphthalene (a specific PAH chemical found in coal tar sealants) has a NIOSH full-shift REL of 10 ppm, and a NIOSH short-term exposure limit (STEL) of 15 ppm [5].

Methods also exist to assess worker exposure to PAHs by testing biological specimens including urine and blood. The 1-hydroxypyrene (1OHP) biomarker, an indicator of internal dose, is a urine metabolite of pyrene, a compound present in almost every PAH mixture [13]. 1OHP measured in urine is the biomarker identified as the recommended biological exposure index (BEI) for PAHs by the American Conference of Governmental Industrial Hygienists [14]. The urinary 1OHP level increases with PAH exposure during the workday, and decreases again with time away from work. There is some 1OHP accumulation during the workweek in post-shift urine samples, and on a week-to-week basis for several months. The urinary 1OHP level in post-shift urine samples mainly reflects an individual’s daily variable PAH exposure, while a pre-shift level of urinary 1OHP taken at the beginning of a week (i.e. after about 2 days away from work) reflects chronic exposures [13]. Cotinine, the primary metabolite of nicotine, has been identified as an indicator of tobacco smoke and can be used to identify PAH contributions from this non-occupational source of exposure. Urinary cotinine levels provide a valid and quantitative measure of average recent human environmental tobacco smoke exposure and is the preferred biomarker of exposure to tobacco smoke in active smokers and in nonsmokers exposed to environmental tobacco smoke [15].

Micronuclei will be used in this study to evaluate the genotoxic potential of the coal tar sealant to which the worker is exposed. Micronuclei are small, round to oval shaped deoxyribonucleic acid (DNA)-containing structures found in blood that originate from chromosome fragments or from the loss of whole chromosomes. Elevated micronuclei frequency in blood will be used as a biomarker of effect potentially related to PAH

exposure since this measure has been identified as a surrogate marker of defects in DNA repair and chromosome segregation. A database containing historical control values, available at the laboratory performing the micronuclei analysis, will be used in the evaluation of the results. In addition, one or two control samples will be obtained if appropriate individuals are available. Two large international collaborative studies have shown that increased lymphocyte levels of micronuclei predict a higher incidence of cancers several years later [16, 17].

Once absorbed, PAHs are metabolized to species that can bind to DNA (DNA adducts) which may initiate the carcinogenic process [18]. A study among rubber manufacturing workers found that DNA adducts in exfoliated urothelial cells correlated well with 1OHP and mutagenicity, whereas blood DNA adducts did not correlate to any external or internal exposure markers, including urinary adducts [19].

Study Rationale:

The NTP has a Polycyclic Aromatic Compounds Mixtures Assessment Program (PAC-MAP) which aims to increase understanding of the toxicity of PACs and PAC mixtures, and has expressed interest in further exposure research on the topic. The NTP conducts toxicological research and needs information from occupational exposure assessment research studies estimating workers' exposure levels to complex real-world mixtures containing PAHs to assist in guiding further toxicological research. NIOSH researchers became aware of recent environmental studies which concluded that coal tar based pavement sealant may be an important source of PAHs in environmental air, particularly at freshly-coated work sites [10]. Airborne exposure level data and biological monitoring data for PAHs are lacking for coal tar sealant workers in the published scientific literature. NIOSH researchers will conduct a study in order to assess occupational exposures to PAHs and coal tar pitch volatiles during use of coal tar sealant paving products.

Study Objective:

The overall study objective will be to conduct a series of field surveys to develop a representative occupational exposure assessment of PAH exposure for RTS applicators. The study will address pavement sealing applications (although other coal tar sealant application activities may be included if other unstudied use of these RTS products is identified). These surveys will be targeted to evaluate a total of approximately 200 worker-days, collecting personal breathing zone air samples for PAH analysis, and collecting biological samples for PAH metabolite analyses. The intent will be to identify and survey workers using the most commonly employed pavement sealant methods and products; as well as to include some jobs with the potential for relatively high exposure (e.g. large in areal extent or using RTS with near 35% R-12 content). An objective will be to monitor workers performing similar tasks across these application methods and products. The specific aims of this work will be: 1) to quantify full-shift airborne occupational exposures to PAHs/coal tar pitch volatiles for blacktop pavement sealant applicators using coal tar based sealants; 2) to assess biomarkers of internal PAH exposure in urine (1-hydroxypyrene and other PAH metabolites); 3) to assess biomarkers of effect potentially related to PAH exposure in blood (micronuclei frequency); 4) to identify specific job tasks associated with RTS application work and assess task-based PAH airborne exposures; 5) to assess dermal exposure levels to PAHs; 6) to obtain bulk samples to evaluate PAH content of the material being applied and for the use of NTP; 7) to use results of the exposure assessment to identify areas for improvement to reduce worker exposure potential with regard to

engineering controls, administrative controls, personal protective equipment, and related best practices for this industry.

METHODS

Identifying and Selecting Companies and Survey Sites:

This study will focus on evaluation of job sites where pavement sealing with coal tar sealant products is performed. This work is expected to primarily involve construction contracting companies with expertise in pavement sealing. These companies typically employ crews which move from job site to job site as the work is completed. Several methods will be used to identify candidate companies. Contacts will be made with appropriate contracting companies, organizations representing sealant application contractors, organizations representing workers, and/or entities requiring the performance of such work, to identify study companies and survey sites. We will use referrals, internet searches and other publicly-available information. Preference will be given to selection of sites where it is likely that the performance of the work will allow NIOSH to monitor the same crew of workers for several consecutive days. As practicable, the areal extent (i.e. large, medium and small), the composition of the sealant (i.e. % coal tar), and the sealant application methods (e.g. truck application, manual spraying, brushing, etc.) will be considered in order to obtain a representative selection of study sites with potential for worker exposure to PAHs. Collection of personal air samples, urine samples, and dermal wipe samples will be required for all surveys. In addition, if possible, NIOSH will collect blood samples during the survey; collection of blood samples will be voluntary for participants. Some worksites may not be suitable for blood collection.

Recruitment and Selection of Participants:

NIOSH will conduct a preliminary visit with the contracting company performing the pavement sealing work to explain the study and to identify worker positions/job titles to be monitored. Both men and women who work with pavement sealants are eligible for this study. No exclusion criteria other than being under the age of majority have been identified. The employer's workers involved in these jobs will be contacted and a study consent form will be reviewed with them by NIOSH in an individual or group meeting, as appropriate. Worker participation in this study is voluntary. Questions will be addressed by the NIOSH representative at that time. If non-English speaking workers are included NIOSH will provide appropriate translation and forms so that the workers can understand the consent form and have their questions answered. The NIOSH representative will obtain consent of the workers who agree to participate in the exposure monitoring study. If a worker declines to wear the air sampling pump, to provide urine samples, or to provide dermal wipe samples as described in the consent form, they will not be eligible for the study. Workers who agree to these items in the consent form by signature, will be considered as consenting participants. In addition, the form will include a separate signature block for the worker's consent for blood sampling and analysis. It is expected that the number of crew workers will typically be small (3 to 6), and these workers will perform tasks such as the following: site preparation; preparation of RTS equipment and supplies; application of sealant to difficult areas (e.g. use of brushes or other tools where overspray is not wanted); application of sealant to the general area; assisting with general application (e.g. handling supply hoses, moving sealant tank); cleanup; and general oversight of work. Up to

about 6 workers will be selected as study participants for each survey. One or two office workers will be invited to participate as non-exposed controls for each survey. If the number of workers in a given survey exceeds the number that NIOSH can sample, those performing work tasks with the most potential for exposure to RTS will be selected from among the consenting participants.

Field Surveys:

A total of 14 field surveys are planned for this study, resulting in approximately 200 worker-days sampled. Each survey will include repeated sampling of a crew of workers over a period of several days. A minimum of 12 worker-days will be required to conduct a survey (e.g. 3 sampled workers over a period of 4 consecutive days). NIOSH will arrange with the company, and other relevant parties, to conduct exposure monitoring at the job site(s) for the duration of each survey. Depending on the size of the contracted work, it may be necessary to follow a company to more than one site to achieve the minimum of 12 worker-days sampled during a survey. The first two field surveys will serve as pilot studies to observe worker tasks, to identify potential exposure hazards by source and route, to evaluate sampling strategies, and to compare and test methods of analysis (see Pilot Survey Additions). Revisions to the protocol (e.g. study methods, sampling strategies, analytical methods, agents of interest, etc.) will be addressed during this period. Any revision(s) of the protocol will be made considering the results of the particular pilot survey addition, in light of study considerations including the following: contribution to the study aims; impact on project cost; impact on project schedule.

As described below, NIOSH will conduct: 1) air monitoring, 2) urine monitoring, 3) dermal monitoring (skin wipe/hand wash), and 4) and blood monitoring. All samples will be shipped or carried to the laboratories for analysis following standard procedures. Methods to ensure confidentiality of participants' personal information, and to ensure informed consent of workers, and related matters concerning the handling and control of samples and results will be employed. Participants will be reimbursed \$75 for their time and inconvenience if they complete all required monitoring involving collecting urine samples, and co-operate in wearing air samplers and obtaining hand wipe samples during the complete duration of the survey. If a participant drops out the amount of reimbursement will be prorated based on the portion of the survey completed. In addition, if they also agree to collection of a blood sample, workers will be reimbursed an additional \$25. Controls will be reimbursed \$25 for their time and inconvenience if they provide a urine sample or a blood sample, \$50 if both a urine and a blood sample are provided.

Air Sampling

NIOSH air sampling and analytical methods [20] will be used to quantify occupational exposure levels of airborne PAHs and coal tar pitch volatiles. Personal sampling pumps and appropriate filter/sorbent media will be used to measure full-shift airborne occupational exposures for the workers. Air sampling will be performed to evaluate airborne exposure levels during specific job tasks. Information about the work tasks performed, methods used, and other details associated with the collected sample will be recorded by the NIOSH study team.

Air samples will be analyzed for the following PAH chemicals:

Acenaphthene

Acenaphthylene
Anthracene
Benz[a]anthracene
Benzo[b]fluoranthene
Benzo[k]fluoranthene
Benzo[g,h,i]perylene
Benzo[a]pyrene
Chrysene
Dibenz[a,h]anthracene
Fluoranthene
Fluorene
Indenol[1,2,3-cd]pyrene
Naphthalene
Phenanthrene
Pyrene

Samples will be collected by NIOSH, and will be analyzed by the NIOSH contract laboratory using NIOSH Method: NMAM 5528 "Polynuclear Aromatic Hydrocarbons in Air by GC-MS SIM". This method includes personal sampling for particulates as well as volatiles and semi-volatiles on OVS-7 [XAD-7 resin/glass fiber filter], followed by laboratory analysis using Gas Chromatography-Mass Spectrometry Selected Ion Monitoring (GC-MS SIM). Other NIOSH analytical methods for PAH analysis will be employed if PAH amounts collected on a sample are not detectable in the laboratory by GC-MS SIM. High-performance liquid chromatography (HPLC), fluorescence and ultraviolet (UV) detection (NMAM 5506), while not as specific for these PAHs as GC-MS SIM, is more sensitive and will be used if PAHs are not detectable using GC-MS SIM. If these PAH chemicals are not detectable by either of these methods, the samples will be analyzed by flow injection – fluorescence (NMAM 5800) for total polycyclic aromatic compounds (PACs) as a class.

In addition, at least one personal air sample will be collected for analysis of coal tar pitch volatiles during each survey using (NIOSH Method: NMAM 5042) "Benzene Soluble Fraction and Total Particulate (Asphalt Fume)" (i.e. collection of particulates on tared 37-mm, 2µm, PTFE filter, and laboratory gravimetric analysis). This method does not capture volatiles, nor does it capture all semi-volatiles, but is of interest because it has been used historically for measurement of coal tar pitch volatiles.

Pilot survey additions (air sampling):

The following additional activities will be conducted during a pilot survey:

- 1) Direct-reading instruments will be used and the feasibility of including one or more of them in the study protocol will be evaluated. Direct-reading air monitoring instruments to be used by the NIOSH study team include photoionization instruments, flame ionization instruments, and a personal PAH monitor. Instruments will be evaluated for their utility for accomplishing various study aims including: to use real-time monitoring capabilities to identify tasks with elevated contaminant levels so task-based PAH personal sampling can be performed during the survey; and to identify areas for improvement that could reduce worker exposure potential (e.g. to use direct reading instruments to identify activities or equipment associated with elevated contaminant levels so that work practice improvements can be recommended).

- 2) Organic compounds containing nitrogen as well as carbon in the ring structure (N-heterocyclics) are also potentially present in RTS, and are of interest for exposure assessment, so samples will be analyzed to evaluate the feasibility of their inclusion in the protocol. The air samples collected by NMAM 5528 methods, as well as bulk samples, will be analyzed for four N-heterocyclics (acridine, carbazole, isoquinoline, and quinoline) using the principle of surrogate standard employed in EPA toxic organics (TO) series methods. The results of the measurement of airborne exposure levels of these additional chemicals potentially present will be evaluated for their utility in accomplishing the study aim to identify areas for improvements to reduce worker exposure potential (i.e. identification of additional potential hazards associated with sealcoating that may need to be addressed).

Urine

Two urine samples (one pre-shift and one end-shift) will be collected per worker on each workday. A brief interview will be conducted with the worker to obtain information to help interpret the urine sample results. Information requested will include time since last RTS workday, number of RTS days worked in previous weeks, and non-occupational sources of PAH exposure. Urine samples received will be labeled for identification, coded so as to protect confidentiality, tested for specific gravity using a refractometer, prepared and placed in storage for subsequent laboratory analyses.

Urine samples will be analyzed for the following:

- 1-hydroxypyrene
- 1-hydroxynaphthalene
- 2-hydroxynaphthalene
- OH-PAH total metabolites
- cotinine
- creatinine

Biomarkers of internal PAH exposure including 1-hydroxypyrene (1OHP), 1-hydroxynaphthalene, 2-hydroxynaphthalene, and OH-PAH total metabolites will be analyzed by NIOSH staff using immunoassay methods. NIOSH will perform these urinary OH-PAH metabolite assays by modifying an existing commercial product designed for the measurements of PAHs in water. The method employs immunoassay principles to detect PAHs in aqueous samples and will substitute hydroxyphenanthrene as the standard [22].

Cotinine (Nicotine-N-oxide), a metabolite of nicotine, will be analyzed by NIOSH staff. The level of cotinine in the urine samples of the workers will be used to determine a worker's exposure to nicotine in tobacco products and other nicotine containing products. Cotinine will be measured in urine samples using the Diagnostic Products Corporation Immulite® 2000 analytical platform. The Immulite® 2000 is an automated immunochemical-based detection platform. The cotinine assay is an FDA approved method that is capable of differentiating passive from active tobacco users [21].

NIOSH will analyze all urine samples to quantify the amount of creatinine, which will be used to normalize the urinary metabolite results. Measurements will be performed with the Vitros Autoanalyzer (Ortho Clinical Diagnosis). The Vitros system utilizes specialized slides that contain all the analytical reagents. The VITROS CREA slide is a multilayered, analytical element coated on a polyester support. After application of a sample,

creatinine diffuses to the reagent layer, where it is hydrolyzed and eventually oxidized to produce a colored product. The resulting change in reflection density is measured at 2 time points. The difference in reflection density is proportional to the concentration of creatinine present in the sample [21].

Pilot survey additions (urine):

The following additional analyses will be performed on urine samples during a pilot survey. The results of these analyses will be used to determine if changes should be made in the protocol.

- 1) OH-PAH metabolites by Gas Chromatography / High Resolution Mass Spectrometry (GC/HRMS) on each urine sample

The Centers for Disease Control and Prevention, National Center for Environmental Health (NCEH) in Atlanta, Georgia, will be responsible for the analysis of urine samples using a previously published method [23]. The method is based on enzymatic de-conjugation and automated liquid-liquid extraction with gas chromatography/isotope dilution high-resolution mass spectrometry after derivatization of the OH-PACs to the trimethylsilylated derivatives. This GC/HRMS analysis will be used to provide comprehensive OH-PAH metabolite results for comparison with results obtained using the immunoassay methods described above to allow adjustment of the study protocol if appropriate. The GC-HRMS method does detect hydroxyl-PAHs associated with coal tar but typically, these are not found in urine since they are predominantly excreted in bile. Unless the pilot urine samples are found to contain hydroxyl-PAHs associated with higher ring number PAHs, because the immunoassay methods are significantly less expensive but, correlate well with the GC-HRMS method results (and additionally detect alkylated, higher ring number and substituted hydroxyl-PAHs) they are preferred.

- 2) DNA adducts on one mid-week pre-shift urine sample per person

During a pilot survey, DNA adducts in exfoliated urothelial cells will be measured to explore the extent of DNA binding or adduct formation. The University of Cincinnati, Department of Environmental Health will be responsible for this analysis. Results will allow determination of the feasibility of using these biomarkers to estimate the effective dose to the genome of PAH exposure during coal tar seal application, so that adjustment of the study protocol can be made if appropriate. For each worker the cells from one mid-week, pre-shift urine sample will be obtained for this analysis. A urine sample will also be obtained from 1 or 2 controls for this analysis if appropriate individuals are available to be sampled. Cells will be preserved and shipped on dry ice to the laboratory. DNA adduct levels will be determined by ³²P-postlabeling as described by Rothman et al. [24]. The ³²P-postlabeling procedure entails four consecutive steps: digestion of modified DNA to 3'-mononucleotides; incorporation of ³²P into the latter; removal of normal nucleotides; and thin-layer chromatography separation and autoradiography of ³²P-labeled adduct nucleotides. Adduct levels are then quantified by scintillation counting [25].

Skin Wipe/Hand Wash

Dermal wipe samples will be obtained and analyzed by the NIOSH contract laboratory to assess worker dermal exposure levels to PAHs and to aid in the interpretation of biological monitoring results. We will obtain hand and neck skin wipe samples on one day for each worker. These samples will be obtained pre-shift and end-shift, on the same day, based on the method described in Fent et al. [26]. The NIOSH study team will collect data to identify tasks, work practices, hygiene practices, PPE use and other information associated with the sample period to help interpret the results. Dermal wipe samples received will be packaged, labeled for identification, prepared and placed in storage for subsequent laboratory analyses. Dermal wipe samples will be analyzed for the same PAH chemicals as the air samples using NIOSH Method: NMAM 5528 "Polynuclear Aromatic Hydrocarbons in Air by GC-MS SIM" or other NIOSH methods as appropriate (see above).

Blood

Blood samples will be obtained and analyzed for evaluation of biomarkers of effect potentially related to PAH exposure. One blood sample will be obtained for each consenting worker at the end of the shift on the final day of the survey. A blood sample will also be obtained from 1 or 2 controls for this analysis if appropriate individuals are available to be sampled. NIOSH will draw the blood specimen, and then label, code, store and ship the sample to the NTP laboratory using specified procedures. NIOSH will follow NTP laboratory requirements for sample storage and shipping for micronuclei. Collected blood samples will be fixed according to MicroFlow™ kit instructions (Linton Laboratories, Rochester, NY) [27].

Bulk sampling of sealant material

In order to help interpret the exposure monitoring results, one bulk sample of sealant material will be collected, per survey, for analysis of PAH content by NIOSH using the same NIOSH analytical method(s) described in the air sampling section above. Additional bulk samples may be obtained for NIOSH analysis if more than one lot of sealant product is used during a survey.

Bulk samples of sealant material will also be collected and shipped to NTP. These samples will be archived by NTP for evaluation regarding possible toxicology testing in the future.

Exposure Determinants

Various factors concerning the work activity may have an effect on determining the exposure monitoring results that are obtained, so information will be collected to allow evaluation of these factors. We will collect information (primarily by observation) on sealant application methods (e.g. spray truck, spray wand, hand brush or roller), on the specific work tasks performed by the participant, on the area of pavement being sealed, on participant use of personal protective equipment (PPE), on type of clothing worn, on hygiene practices, on any engineering, administrative or work practice controls used, on spills or other unusual conditions, and on ambient

environmental conditions. We will also obtain information on the PAH content of the sealant material being applied. Other factors concerning the individual participant may also have an effect on determining the exposure monitoring results that are obtained. Information on pavement sealing work performed during the preceding day(s)/week(s), demographic information, trade identified with, and information on non-occupational sources of PAH exposure, such as smoking or passive inhalation of tobacco smoke, and ingestion of grilled or smoked foods, will be obtained from each worker through a brief researcher-administered interview.

This information will be used to help understand the exposure monitoring results for the samples (air, urine, skin wipe/hand wash, and blood) collected from the workers.

Data Analysis

NIOSH will review all worker monitoring results and will enter the verified results into a database. Results will be organized into groups as appropriate, and descriptive statistics will be calculated. For example, the mean (arithmetic or geometric as appropriate), median, standard deviation, maximum and minimum concentration (milligrams/cubic meter of air) for the airborne chemical agent known as coal tar pitch volatiles will be calculated for the group which includes all workers in the study sampled for coal tar pitch volatiles. Descriptive statistics will also be applied to study workers grouped by job/task assignment (e.g. wand spray application workers). Mixed effect modeling will be used to study correlation between various monitoring results (i.e. air urine, skin wipe/hand wash, and blood) as appropriate with person and site as the random effects. Differences in worker monitoring results categorized by determinants of exposure (e.g. sealant application method, percent PAH content in the sealant, worker smoking status, etc.) will also be tested. Linear least square regression analyses will be carried out to describe the association between micronuclei frequency and 1-hydroxypyrene levels adjusting for urinary cotinine levels. In all analyses, where appropriate, the log of exposures will be evaluated to satisfy normality assumptions.

Study Time Line

The first year will focus on protocol refinement and review, Institutional Review Board (IRB) approval, recruitment and contact with companies, observation of worker tasks, and two pilot field surveys. Protocol refinement will include selection of methods and sampling strategies best suited to assess occupational exposures, as determined by the results of the two pilot surveys. Recruitment may begin with local companies, followed by establishing industry contacts in a wider area.

Years two and three will be focused on protocol refinement and expanding recruitment efforts to include both local and regional (Midwest) users of coal tar sealant products in blacktop sealing. The preliminary goal for 2016 is to conduct six (three local and three regional) surveys. Recruitment for six field surveys in 2017 will be focused on both local and regional users, and on groups that lack data, or are deemed of particular interest. Publication of results in a peer reviewed journal will be an overall project goal as research is completed.

Data Management

Data management will include sample chain-of-custody, use of data forms for recordkeeping, and secure procedures for handling personally identifiable data. Study participants will be given unique identification

numbers which will be used to manage their data. In the field all personally identifiable information (PII) will either be with the project officer, or on an encrypted flash drive or encrypted laptop computer. At NIOSH offices, personally identifiable information will be kept either in a locked file cabinet or in a restricted access computer folder backed-up daily on the CDC network. Samples sent to laboratories will be assigned a code number. Individual names will not be placed on laboratory samples. Records linking names and addresses to code numbers will be stored separately from samples in a locked file accessible only to NIOSH personnel. Any portion of biological samples remaining after analysis will be returned to NIOSH for storage, or will be handled as otherwise determined by the project officer. These extra urine and blood samples will be stored without personal identifiers. It is possible that future studies may want to do further testing of these biological samples. A separate, optional item on the participant consent form allows the participant to choose whether or not their de-identified samples may be used in future studies.

Risks and Benefits for Study Participants

Injury or harm from this project is unlikely. As is the case with any blood draw, the needle stick may produce some discomfort and possibly some soreness and discoloration of the skin due to blood leaking from the vein; this discoloration may last a few days but it is generally harmless. Infrequently, drawing blood can cause fainting. An experienced NIOSH phlebotomist will perform the blood draw. All NIOSH phlebotomists are certified or are qualified by training and experience. The blood draw will be done using a chair designed for this purpose and will take place in a NIOSH trailer or at some other suitable indoor location. No known physical risks are associated with providing urine samples, or with collection of air samples or skin wipe/hand wash samples. If no other suitable facilities are available, NIOSH will provide a privacy tent for workers to provide urine samples. Survey reports provided to companies and unions (if applicable) will be prepared to minimize the risk that results could be associated with any particular individual. Data will be combined and/or summarized to accomplish this, and reports will be sent to the NIOSH Institutional Review Board (IRB) for review prior to dissemination. Participants will not directly benefit from this research, but may indirectly benefit from the knowledge gained by this research as it pertains to understanding sources of polycyclic aromatic hydrocarbons, and understanding methods of reducing exposure to them.

Emergency care

It is unlikely that emergency care will be needed related to this study, however on-site emergency treatment will be provided if the blood draw or other NIOSH activities result in injury or harm. 911 will be called if needed. Medical care or compensation will not be provided.

Notifying Participants of Individual Results

Workers participating in this study will have the option (in the consent form) of being notified of their individual results at the end of the study, in accordance with the NIOSH Policy for Notifying Workers of Individual Environmental Sampling and Monitoring Results. Results will be provided together with any pertinent occupational exposure limits. All participant notification materials will be submitted for approval to the NIOSH IRB prior to dissemination.

Summary of Results to Participating Companies and Labor Unions

Companies participating in the study will receive a survey report with results along with any recommendations on reducing exposures. Companies will not receive any individual participant's results. If participating employees are represented by a union, that union will also receive the survey report.

AUTHORITY AND TRADE SECRET PROTECTION

NIOSH is the federal agency responsible of conducting research and making recommendations for the prevention of workplace injuries and illnesses. NIOSH conducts its research pursuant to the Occupational Safety and Health Act, 29 U.S.C. §§ 651-676 (Occupational Safety and Health Act of 1970). The agency's authority to conduct its research, to enter places to do this research and to obtain the records from employers that are needed to do its research are specifically set out in the OSH ACT at 29 U.S.C. §§ 669 and 657. In exercising these authorities, NIOSH may obtain trade secret, confidential and proprietary information and/or personally identifiable information pertaining to employees from an employer. NIOSH maintains information obtained from employers in accordance with the Federal Trade Secrets Act, 14 U.S.C. § 1905 the Occupational Safety and Health Act 29 U.S.C. §§ 664, the Freedom of Information Act, 5 U.S.C. § 552 (FOIA), Executive Order 12600, the FOIA regulation of the Department of Health and Human Services, 45 CFR Part 5, and the NIOSH research regulations at 45 CFR Part 85a.

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APPENDIX A

Consent to be in a Research Study



Consent to be in a Research Study

Assessment of Occupational Exposure to PAHs in Coal Tar Sealant Applications

1	Who is conducting the study?	The National Institute for Occupational Safety and Health (NIOSH) is conducting the study. NIOSH is a federal agency that studies worker safety and health. We are part of the Centers for Disease Control and Prevention (CDC).
2	What is the purpose?	This study will evaluate the levels of occupational chemical exposure among workers who are using coal tar-based pavement sealants. You, along with up to 100 workers who work with coal tar and asphalt sealants, are being invited to participate in this study. We will be determining exposures to a group of chemicals known as polycyclic aromatic hydrocarbons (PAHs) through collection and testing of urine, blood, air, and skin wipe samples.
3	What will I do?	<p>As a participant in this study you will be asked to:</p> <ul style="list-style-type: none"> • wear a sampling pump during your shift so an air sample can be collected. These air samples will be analyzed to measure PAHs present in the air near you during your workday. • collect your urine in a container provided by NIOSH. The urine sample will be used to measure compounds in your urine known to be associated with exposure to PAHs (i.e. metabolites). • allow NIOSH personnel to collect a sample by wiping your skin (e.g. hands). These samples will be analyzed to measure PAHs. • tell us about your recent work activities and other possible uses of PAHs and other items that can help us interpret the test results. <p>If you decline to wear the air sampling pump, decline to provide the urine samples, or decline to allow the skin wipe, you will not be eligible to participate in the study.</p> <p>IN ADDITION: NIOSH will also ask participants if they want to volunteer to allow a blood sample to be drawn. If you decline to provide the blood sample you can still participate in the other parts of the study. The blood sample will be analyzed for biomarkers of effect, potentially related to exposure to PAHs.</p> <p>NOTE: No HIV or drug tests will be performed on any of your samples.</p>
4	When, where, for how long will I be needed?	NIOSH will come to your worksite. Each day of the survey you will be needed at the beginning of the day (before you begin work), and at the end of the day. At these times you will be asked to provide urine samples; and we will attach/remove your air sampling pump; and ask some questions to help us interpret your results. This should only take about 10 minutes at the

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		<p>beginning and at the end of each workday. You may also be asked to allow us to remove/attach the air sampling pump periodically during the day.</p> <p>On one of the survey days NIOSH will also collect 2 skin/hand wipe samples which will add about 5 more minutes at the beginning and at the end of that workday.</p> <p>If you agree to allow a blood sample to be drawn, that will occur at the end of the last day of the survey, and will take about 15 minutes.</p>
5	Are there any risks?	<p>There are risks of donating blood that include some soreness and discoloration of the skin due to blood leaking from the vein; this discoloration may last a few days but it is generally harmless. Infrequently, drawing blood can cause fainting. An experienced phlebotomist and a chair designed for blood draws will be used. There are no other known physical risks associated with providing air, urine, skin wipe or blood samples.</p> <p>There is the potential for psychological/social stress related to privacy and confidentiality. Investigators will minimize the risk of loss of confidentiality by identifying samples and information by code only, and by only releasing non-identifying, summarized information to your employer, or in publications.</p>
6	Is my participation voluntary?	<p>The study is voluntary. You may choose to be in the study or not. You may choose to answer any or all questions. You may drop out any time for any reason without consequences to you.</p>
7	What if I'm injured or harmed?	<p>On-site emergency treatment will be provided if the blood draw or other NIOSH activities result in injury or harm to you. 911 will be called if needed. Medical care or compensation will not be provided. If harmed through negligence of a NIOSH employee, you might obtain compensation under Federal Law. If a NIOSH contractor is negligent, you can file a claim with that contractor.</p>
8	Will I be reimbursed or paid?	<p>If you participate during all days of the NIOSH survey and provide all of the urine samples, as well as allowing NIOSH to obtain all of the air and skin wipe samples identified, you will be reimbursed \$75 for your time and inconvenience. If you drop out, the amount of the reimbursement will be reduced based on the portion of the survey you did not complete. If your NIOSH survey also asks for volunteers for collection of blood samples, and if you allow NIOSH to collect your blood sample (in addition to all of the urine, air, and skin wipe samples) you will be reimbursed an additional \$25 (a total of \$100) for your time and inconvenience. You will be informed whether blood samples will be collected during your survey before you sign this consent.</p>

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Assessment of Occupational Exposure to PAHs in Coal Tar Sealant Applications

9	Are there other benefits?	As a participant, you will not directly benefit from this study. You may indirectly benefit from the knowledge gained by this research as it pertains to understanding sources of polycyclic aromatic hydrocarbons, and understanding methods of reducing your potential for exposure.
10	What alternative procedures might benefit me?	None have been identified.
11	Will my personal information be kept private?	NIOSH is authorized to collect your personal information and will protect it to the extent allowed by law. There are conditions under the Privacy Act where your information may be released to collaborators or contractors, health departments or disease registries, to the Departments of Justice or Labor, or to Congressional offices.
12	Will I or anyone else receive study results?	<p>The NIOSH research team will provide you with the results of the analyses of your samples (urine, air, skin wipes and blood) if you request them. Your results will be provided together with any pertinent occupational exposure limits, if available. The letter containing these results will be written directly to you and will not be sent to your employer. It should be noted that this is a multi-year study at several different facilities, and results may not be mailed to individuals until after the completion of the entire study.</p> <p>A final report of the study, without any codes which could identify you, will be sent to your employer. If you are represented by a union, that union will also receive the survey report. If the results are published in a scientific journal, only summary data will be reported so that you cannot be individually identified.</p>
13	Who can I talk to if I have more questions?	<p>For questions about the research study, contact the principal investigator, Donald A. Fleming at dmf9@cdc.gov or 513-841-4490, or contact the Industrywide Studies Branch at 513-841-4203.</p> <p>For questions about your rights, your privacy, or harm to you, please contact the Chair of the NIOSH Institutional Review Board (IRB) at phone number 513-533-8591.</p>
14	Your signature	<p>The study was explained to me. My questions were answered. I agree to be in the study.</p> <p>_____</p> <p>Printed name of participant</p> <p>_____</p> <p>Participant signature Date</p> <p>I have accurately described this study to the participant.</p> <p>_____</p> <p>NIOSH representative signature Date</p>

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Assessment of Occupational Exposure to PAHs in Coal Tar Sealant Applications

15 Additional consents

1) If there is extra urine and/or blood left after we have met the needs for laboratory tests for this study, the NIOSH research team would like your permission to allow the extra sample to be used in other studies. NIOSH will protect your privacy. If you give permission to do so, any extra sample would be recoded prior to release to other studies or placement into storage so that it would **not** be possible to link the source of the sample back to you. Any future testing of extra (stored) urine in other studies will be done only after your samples have been stripped of personal identifiers, therefore, it will **not** be possible for the NIOSH team to report these results back to you.

I give permission to store urine and blood samples for possible use in other studies.

Printed name of participant

Participant signature

Date

2) You will be asked to provide one blood sample. You may still participate in the rest of the survey if you decide not to have a blood sample collected. The blood sample will be collected at the end of the workday on the last day of the NIOSH survey.

I agree to blood sample collection.

Printed name of participant

Participant signature

Date

3) You may request a copy of your individual exposure measurement results by printing and signing your name below. It is important to understand that at this time we do not know how to interpret an individual's exposure results with regard to an individual's own health or risk. The results will be mailed to you after they have been verified and approved for release, which may not occur until the end of this study.

I request that you please send my individual monitoring results to me.

Printed name of participant

Participant signature

Date

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PARTICIPANT'S MAILING ADDRESS (Please complete if you are requesting individual monitoring results):

Street Address or P.O. Box: _____

Apt. No.: _____

City: _____ State: _____ Zip: _____

NOTE: If your address changes and you would still like to receive you individual results, please provide your updated address to:

Donald Fleming
National Institute for Occupational Safety and Health
1090 Tusculum Ave, R-14
Cincinnati, OH 45226

Phone: 513-841-4490 or 513-841-4203

APPENDIX B

Information collected to help interpret sample data

We will make observations during sampling of the work activities to help us interpret the laboratory results. For example, the various factors that could influence the extent of worker exposure such as time workers spend applying sealant, and the ambient temperature will be noted and recorded.

We will also ask workers about other matters, which cannot be observed during the work, and may have an effect on their laboratory results. This information will be collected during the time the samples are obtained and will be coded to protect confidentiality.

In connection with urine samples the following information will be requested:

- What is your date of birth _____?
- When was the last time you worked on a coal tar sealant job prior to today (first sample collection day) _____?
- How many days have you worked on coal tar sealant jobs during the past 30 days _____?
- Do you smoke? If yes, how many cigarettes/cigars do you smoke per day currently _____? How many years have you smoked _____? If you are not currently a smoker, how many cigarettes/cigars did you smoke per day (on average) _____?
- Have you performed firefighting in the past 30 days (circle one): Y / N
- Have you used ointments or medications containing coal tar (such as Oxipor or MG217 for psoriasis)? (circle one): Y / N

In connection with blood samples the following information will also be requested:

- How many alcoholic drinks (such as beer, wine or liquor) do you have per day currently _____? How many years have you had alcohol _____?
- Have you had any x-ray procedures in the last 3 months (not including dental) (circle one): Y / N
- Were you ever treated with radionuclides, anti-retroviral drugs, or cancer chemotherapeutic drugs (circle one): Y / N

In connection with dermal wipe samples the following information will be requested:

- How many times have you washed your hands today (during the workday) _____?