

IV. ENVIRONMENTAL DATA AND ENGINEERING CONTROLS

Environmental Data

In 1974, NIOSH [5] conducted an environmental investigation of US aluminum reduction plants using carbon electrodes made of coal tar pitch. Air samples were collected from several plant areas, such as prebaked-potrooms, horizontal and vertical Soderberg potrooms, carbon plant-prebaked anode block production areas, Soderberg anode paste production areas, and cathode mixing and forming areas. Personal air samples were also collected for several workers, including potroom workers, tappers, head pin setters, hijackers, and anode cranemen. All personal and area samples were analyzed for coal tar pitch volatiles (CTPV's). The filters were weighed, extracted with hot benzene in a Soxhlet extractor, air dried, and reweighed. The air samples were also analyzed for total airborne dust, and some of the benzene extracts were analyzed for individual polynuclear aromatic hydrocarbons. The TWA concentrations were calculated from personal and area samples. Environmental data from only two of the four plant surveys were reported because reliable data were not available from one of the plants and the other plant used petroleum pitch.

The data showed that concentrations of airborne CTPV's were highest in Soderberg process potrooms, since the pitch was heated and baked in this part of the processing. The concentrations were as high as 63 mg/cu m in the Soderberg potrooms, 9 mg/cu m in prebaked anode block production areas, 5 mg/cu m in Soderberg anode production areas, 6 mg/cu m in the cathode mixing and forming areas, and 2 mg/cu m in the prebaked potroom. The TWA concentrations were generally highest in the horizontal Soderberg potroom,

where a flex raiser was exposed to CTPV's at 18.5 mg/cu m, a toolman at 17.5 mg/cu m, a pin driver at 12.0 mg/cu m, and a pin puller at 1.5 mg/cu m. In the vertical Soderberg potroom, a tapper was exposed at 12.0 mg/cu m, a head pin setter at 7.5 mg/cu m, and a potman at 2.2 mg/cu m. Exposures recorded in the prebaked potroom were 0.5 mg/cu m for a tapper/anode setter and 0.2 mg/cu m for a potman.

According to the report, [5], there was no provision for local exhaust ventilation over the Soderberg anodes at either of these two plants; only general room ventilation was available for removal of pitch volatiles from the potrooms. The highest TWA concentrations were those of an anode/crane worker in the horizontal Soderberg potroom (35.0 mg/cu m) and a head pin setter (29.0 mg/cu m) and a tapper (20.0 mg/cu m) in the vertical Soderberg potroom.

Chemical analysis of some benzene extracts of air samples showed that they contained PNA's, including benzo(a)pyrene, pyrene, chrysene, benz(a)anthracene, benzo(b)fluoranthene, benzo(j)fluoranthene, benzo(k)fluoranthene, benzo(e)pyrene, and benzo(g,h,i)perylene.

High concentrations of airborne particles have also been reported in USSR aluminum reduction plants (See Epidemiologic Studies). These findings agree with NIOSH [5] observations. NIOSH [30] has also reported concentrations of CTPV's as high as 2.38 mg/cu m during a roofing operation which used coal tar pitch.

Engineering Control of Exposures

Where the concentration of airborne coal tar product particulates and vapor to which workers are exposed might exceed the workplace exposure limit, engineering controls are normally necessary to decrease the concentrations of those airborne products to or below the prescribed limit. Closed systems are commonly used in manufacturing processes, and such systems should be used whenever possible to control the release of particulates and vapor from coal tar products. Closed systems would be operated under negative gage pressure, so the air will flow inward if leaks develop. Frequent inspections and prompt repairs of leaks are required to maintain the effectiveness and integrity of the systems.

Emission of airborne coal tar products as dusts or mists should be controlled by suitable exhaust ventilation equipment if enclosure is not possible. The exhaust ventilation system should be designed, installed, operated, and maintained in accordance with the principles given in the 1976 edition of Industrial Ventilation--A Manual of Recommended Practice [82], or the most recent edition, and in Fundamentals Governing the Design and Operation of Local Exhaust Systems [83]. Ventilation systems for fume and vapor control require regular inspection and maintenance to ensure effective operation, and a program of scheduled inspection should be established. These inspections should include face-velocity measurements of the collecting hood, scrutiny of the air mover and collector, and measurements of workroom concentrations of airborne coal tar products. To ensure that the engineering controls provide adequate protection of employees, the efficiency of the ventilation system must be assessed promptly after changes in operations.

Sampling and Analytical Methods

The effects of coal tar products on humans and animals have been thoroughly discussed in Chapter III, and several conclusions were drawn regarding toxicities of these substances. The overall objective of the sampling and analytical methods recommended by NIOSH is to capture, select, and analyze for the constituents of the airborne coal tar products that are most likely responsible for these toxicities. Several important considerations are readily apparent. The first is that the method selected must be sensitive, accurate, and reproducible. Next, the method must be capable of giving a result which can be related to toxicity. Third, the method should be as simple and economical as possible. Last, the method should not present undue hazards to laboratory personnel.

For the analysis of coal tar products, there are several alternative methods of sampling and several alternative methods of analysis. However, not all combinations of sampling and analysis are practicable, and not all the practicable combinations have been tried. The following discussion concerns successful combinations.

Certain types of mineral oils, chimney soot, and coal tar products are heterogenous natural mixtures found to be carcinogenic in humans after prolonged exposure [84]. Polynuclear aromatic hydrocarbons (PNA's) have been identified in these materials; in some cases hot coal-tar pitch fumes contained more than 50% of these hydrocarbons [84]. PNA's that may be collected as airborne particulates include chrysene, benz(a)anthracene, fluoranthene, the benzpyrenes, anthanthrene, benzofluoranthenes, perylene, dibenzanthracenes, benzfluorenes, dibenzpyrenes, indene(1,2,3-c,d)pyrene, benzo(g,h,i)perylene, coronone, and alkyl derivatives, usually methyl

derivatives, of some of those according to an EPA assessment [19]. Ambient PNA concentrations vary widely in both urban and nonurban areas; some typical concentrations are shown in Table XII-5.

Benzo(a)pyrene (BaP) has been found in samples of particulate polycyclic organic material (PPOM), and this compound has frequently been used to indicate the presence of PNA's. PPOM is commonly reported as total suspended particulates, benzene-extractable organics, or BaP equivalents. BaP is just one of the PNA's found in coal tar pitch volatiles (CTPV).

PPOM samples have been collected on various filter media. In the 1960's the method most often used was to draw air through a high-volume sampler containing a glass fiber filter at a flowrate of 20-100 cu ft/minute. Richards et al [85] recommended using a silver membrane filter for sampling CTPV (or PPOM) because it offered better weight stability than glass fiber, cellulose, or cellulose acetate filters. In a 1973 NIOSH evaluation of methods for sampling and analyzing coke oven emissions, silver membrane filters were found to clog after a relatively short sampling time when emissions or moisture content was high [86]. This problem was eliminated when a glass fiber filter without organic binder was placed ahead of the silver membrane filter within the sampling cassette. This combination of glass fiber and silver membrane filters, supported by a cellulose filter pad, became the standard apparatus used by NIOSH and OSHA and by state and corporation industrial hygienists for the collection of PPOM [87]. This combination of filters has been found to be more effective in collecting airborne particles than either filter by itself [86].

In collecting BaP from hot auto exhaust, Stenburg et al [88] found that some BaP was lost from glass fiber filters when used at 300 F;

however, when the filter was used at 132 F, loss did not appear to be significant.

An EPA assessment [19] concluded that no tetracyclic and larger PNA's were lost from glass fiber filters alone with 2 hours of collection at 1.2 cu m/minute followed by 2 hours of filtered air drawn through the sample at 1.2 cu m/minute. Some tetracyclic PNA's, but no larger PNA's, were lost with 24 hours of collection followed by 24 hours of filtered air. Even when air was pulled through the filter for 3 weeks, the pentacyclic and larger PNA's showed little, if any loss.

It is reasonable to conclude that, in sampling workplace air, negligible losses of the constituents likely to be encountered in sampling coal tar products will occur. Therefore, it is recommended that the combination of glass fiber and silver membrane filters be used for sampling workplace air for coal tar products.

In selecting a method for analyzing the particulates collected on the filter, one must select from a wide range of alternatives, ranging from analyses of all identifiable components to analysis of the total weight of material collected on the filter. Any of these would give an indication of the concentration of airborne coal tar products. However, of the many alternatives theoretically possible in coal tar products, only three are practicable.

One practicable alternative is the analysis of the one or more discrete compounds in coal tar products. Separation is usually necessary if individual PNA's are to be determined. The practicality of any separation technique depends on the ease of handling, separation time, percentage recovery, and reliability of the procedure [19]. Methods used

to separate and concentrate hydrocarbons for analysis include sublimation, vacuum distillation, liquid-liquid extraction, solid-liquid extraction, and column, paper, thin-layer, and gas chromatography [84].

Liquid-liquid extraction has been used to concentrate the PNA's and separate them from sources of interference with later analysis, such as aliphatic hydrocarbons [19]. Column chromatography has been used for preliminary separation of an unknown mixture to determine its PNA composition. However, 12-24 hours are necessary for separation [19]. Paper chromatography also requires many hours for separation. Consequently, these chromatographic techniques are rarely used in routine assays. DeMaio and Corn [89] pointed out that column chromatographic separation procedures followed by UV-visible spectral investigation are tedious and time-consuming, monopolize the time of laboratory personnel, and may introduce a 50% loss of BaP or other compounds on the activated alumina of the separating column. DeMaio and Corn [89] also pointed out that fluorescent spectral methods measuring PNA's in solution and on paper chromatograms have similar limitations.

Thin-layer chromatography can accomplish a large number of compound separations. Organic particulates ranging in weight from 0.02 to 36 mg can be separated in 1 or 2 hours on 20- x 20-cm plates [90]. Two-dimensional chromatography further refines the separation. Ultraviolet light can be used to detect the separation of fluorescent unknowns. A fluorescent spot can be scraped off a plate and extracted, and the fluorescence and phosphorescence spectra of the extract can be determined [90]. This technique is relatively simple, rapid, inexpensive, versatile, and sensitive; it also requires little working material and can resolve complex

mixtures [84]. However, in the analysis of a complicated plate, variability in the fluorescent color and in the number, wetness, and age of the spots can cause difficulty in the interpretation of results [90]. Good laboratory technique is essential with this method, and routine assay of a large number of samples for PNA would be unwieldy [19]. Nevertheless, two-dimensional thin-layer chromatography, especially with mixed adsorbents, followed by direct fluorimetric examination, can be useful in characterizing a large variety of PNA's [91].

Fluorometry has been used after cyclohexane extraction, column chromatography, and thin-layer chromatography to determine BaP and PNA's [92-94]. Inherent problems in the analysis of BaP include background fluorescence, similar fluorescence emission spectra of BaP and benzo(k)fluoranthene, and the quenching effect of other components on the fluorescence of BaP [92].

Gas chromatography [19] is an effective analytical system for separating PNA's. When combined with ultraviolet absorption spectrophotometry [95,96] or some form of mass spectrometry [97], it is one of the best separation methods. Hittle and Stukel [98] achieved satisfactory gas chromatographic analysis of coal tar pitch fumes; the results are shown in Table XII-6. Lijinsky et al [14] reported that gas chromatography was more sensitive than most other analytical methods for PNA's. Most the the PNA's they studied could be separated within 1 hour at column temperatures of 160-210 C and an argon pressure of 15 psi. Lijinsky et al also noted that it was possible to separate individual PNA's from their homologs, including compounds like BaP and benzo(g,h,i)perylene that were difficult to separate by other means. At lower temperatures,

isothermal gas chromatography gave good resolution of low-boiling components but poor resolution of high-boiling compounds. The converse was found at high temperatures. Because it was impossible to select a single column temperature for optimal separation of all PNA's temperature programming was suggested. Lijinsky and Mason [13] further investigated programmed-temperature gas chromatography. Gas chromatographic analysis of coal tar and creosote using a temperature program from 100 to 220 C had desirable results; the component peaks were more uniform in size, resolution of both higher and lower boiling components was good, and all of the major PNA's were detected in approximately 1 hour [13]. This assay method could be automated for plant distillation processes by using an automatic sampling valve linked to a gas chromatograph. Grant [99] reported that laboratory tests using this type of valve with both static systems and distillation units, have given reproducible results. Linkage between gas chromatography equipment and various industrial processes, such as fractional distillation, ultimately may permit monitoring of variables like temperature and reflux ratios from the gas chromatographic output.

Gas-liquid chromatography was recently used by Bjorseth and Lunde [100] after an enrichment and separation process for PNA's collected as particulate matter from the atmosphere of a Soderberg carbon-paste plant. In their method, the filters were extracted with cyclohexane in a Soxhlet apparatus for 6 hours. The cyclohexane solution was extracted with dimethylformamide (DMF) containing 10% water, and the cyclohexane was then subjected to a second extraction with DMF-water. The DMF extracts were combined, diluted with an equal volume of water, and extracted with fresh cyclohexane. The cyclohexane extracts were combined and extracted with

water. After separation of phases, the cyclohexane phase was dried using sodium sulfate and evaporated to 0.5 ml volume using a Kuderna-Panish apparatus. The PNA components were determined using programmed temperature-increase gas-liquid chromatography, starting at a temperature of 165 C with a 4 C/minute increase. The final temperature of 300 C was maintained for 1 hour to allow development of the chromatogram. The two samples analyzed showed similar characteristics in the qualitative distribution of PNA's found. There were 42 PNA compounds identified in the cyclohexane extract.

Based on the data, nine of the constituents accounted for 92-95% of the total PNA's in each sample. These constituents were phenanthrene/anthracene thiophene (1-2%), methylphenanthrene (2-3%), methylantracene (3-4%), benzo(a)anthracene (1-2%), and chrysene/triphenylene (0.1%). The remaining constituents were present at less than 1%.

Gas-liquid chromatography was also used by Hittle and Stukel [98] in analyzing coal tar pitch aerosols generated by blowing air across hot coal tar pitch (125 C) applied to roofing felt or a plywood base. The aerosols were collected by electrostatic precipitation onto glass slides, and the material on the glass slides was dissolved with benzene and analyzed with a gas chromatograph and mass spectrometer. The quantitative composition for the benzene soluble components in the coal tar pitch aerosols is given in Table XII-6.

Gas-liquid chromatographic methods were further developed by Karasek et al [101], to achieve rapid, reproducible, and routine analysis of organic material adsorbed onto particulate matter. High-volume samplers were used to collect PPOM on glass fiber filters. Extraction was performed

in a Soxhlet apparatus.

The gas chromatographic support column used by Karasek et al [101] consisted of a thin film of thermally treated Carbowax 20M on acid-washed Chromosorb W (100/200 mesh). This packing exhibited lower retention times and elution temperatures than a conventional Carbowax 20M column. The shorter retention times gave faster analyses, and the low bleed characteristics significantly eliminated base line shift during temperature programming. An average standard deviation of less than 1% was obtained for all retention index data. The identity of the compounds was determined by obtaining mass spectra of the compounds as they eluted. Comparison of the experimental and cataloged spectra and retention time data allowed definitive identification of various compounds present in the PPOM.

Because of the many possible components in coal tar products, and because the ratios of the quantities of these components in coal tar products may likely vary with substance, process, and time, it is an insurmountable task to select an appropriate compound for analysis. Selection of several is fraught with difficulties because there is insufficient information available to allow the selection of proper groups of compounds. Data may be developed to enable a proper selection to be made. Other principal drawbacks of this first practicable alternative are the great complexity and cost which would be associated with this method. Considerable development of analytical methods and procedures for routine analysis would be required. The toxicity information presented in Chapter III is clearly insufficient to allow identification of the components likely to be the most toxic and carcinogenic to employees; thus, it is

difficult to decide how many of the discrete compounds should be analyzed routinely in the workplace air.

The second of the three practicable alternatives is determination of the total mass of filterable particulates. This alternative is the simplest but suffers markedly when used to analyze samples that contain materials other than coal tar products. Many contaminants in these samples are much less toxic than coal tar products, but this method would not distinguish between toxic and non-toxic components. A major reason for sampling the airborne contaminants is to determine whether or not engineering controls are adequate, and this method would likely not allow this determination.

The third practicable alternative is the analysis of a selected fraction, but not a particular identified compound, of the airborne particulate. This alternative method is more complicated than the second alternative and less complicated than the first. A review of the data and conclusions in Chapter III reveals that, in most studies of the toxicity of coal tar products, a mixture or fraction of the product, and not a discrete compound, has been tested. It is reasonable that a fraction tested for toxicity should be the indicator analyzed in samples of airborne coal tar products. Various methods of analyzing for coal tar products are discussed in the following paragraphs.

Extraction of some components from solid material is one way of removing a material of interest from unwanted and interfering substances. Extraction with a suitable organic solvent in a Soxhlet apparatus has been found to be a convenient, though time-consuming [84], means of separation. In this instance, the filter was removed from the holder and transferred to

a Soxhlet apparatus, where it was extracted with hot benzene for 3 hours. After extraction, the filter was placed in a Millipore filtering apparatus, and the benzene extract was passed through the filters under suction to recover any particulates that were dislodged during extraction. The filter was dried and reweighed; any weight loss was recorded as "benzene solubles" [87,102-104]. This benzene-extractable fraction was used as an index for the presence of the previously mentioned high-molecular-weight polycyclic hydrocarbons with carcinogenic properties [102].

In a critical analysis of the "benzene-soluble" extraction method, Seim et al [87] mentioned many conditions that caused major weight loss errors in the results, including mechanical losses during handling and discontinuous films of fine particles on the glassware that could not be recovered by washing with benzene. Other properties found to affect the measurement of PNA's were the boiling points of individual constituents, differences in solubility, reactivity to oxidants in the presence of light, stability on adsorbents, decomposition during solvent extraction, and collection temperature and airflow rate [19].

In developing the "benzene-soluble" extraction method, other solvents were tried. Sawicki [84] tested several solvents by shaking for 3 hours at 50 C and found that methanol extracted 12.82% of the airborne particulates, acetone 9.00%, chloroform 5.16%, benzene 7.77%, cyclohexane 2.34%, and isooctane 3.90%. However, he noted that the more polar solvents dissolved the more polar organic compounds and some inorganic salts. His data indicated that the percentage of material extracted with cyclohexane was nearly the same at 25 and 50 C; for other solvents this percentage varied more. Sawicki did not indicate which of the solvents extracted more PNA's

than the others.

As discussed above, several solvents can be used for extraction of coal tar products. For many years benzene has been used as the solvent in extractions of this type. Recently, benzene has been found to be much more toxic than it was previously thought to be, and NIOSH has concluded that benzene causes leukemia [105,106]. It is likely that many laboratories which routinely analyze for coal tar products in air are not now equipped to take the precautions necessary to protect laboratory personnel. Thus, NIOSH recommends that the solvent for extraction of coal tar products be other than benzene. Cyclohexane has been used for extractions of this type and will likely extract kinds and quantities of substances similar to those extracted by benzene. Two of the solvents tested by Sawicki [84], acetone and cyclohexane, are likely to have solvent properties similar to those of benzene, according to their solubility parameters [107,108]. Of these two solvents, the lower limits of inflammability of cyclohexane and acetone are 1.26 and 2.55%, respectively, and their vapor pressures at 25 C are 200 and 83.4 mm Hg, respectively. Thus the two solvents would present similar explosion hazards, but the loss of acetone during extraction would be greater. Based on these considerations and because there has apparently been more experience with cyclohexane in extracting coal tar products, it is recommended that extraction be performed with cyclohexane.

To diminish the time required for extraction of samples of coal tar products, the Soxhlet extraction method, which consumes 6-8 hours for efficient extraction, has been modified to accomplish an effective extraction in as little as 5 minutes [109]; this method, using ultrasonication, is currently specified in the federal standard for coke

oven emissions (29 CFR 1910.1029). After the filtrate is extracted, the cyclohexane solution is filtered through a fritted glass funnel. The total material extracted is determined by weighing an aliquot of the extract that has been evaporated to dryness and making the necessary calculation.

V. WORK PRACTICES

As discussed in Chapter III, coal tar pitch, pitch dust, crude coal tar, creosote, or mixtures containing crude coal tar, coal tar pitch, or polynuclear aromatic hydrocarbons (PNA's), have been shown to be carcinogenic. Good industrial hygiene practice requires that all reasonable efforts be made to prevent contact of coal tar products with the skin or eyes and to prevent inhalation of coal tar dust and vapor. Areas of potential exposure to coal tar products should be designated as regulated areas. Access to such areas should be limited to designated employees. Employees should avoid skin and eye contact with solid or liquid coal tar products. They should also avoid breathing coal tar product vapor or dust. If skin contact with coal tar products occurs, the affected area should be washed immediately with soap and water [110,111]. Organic solvents should not be applied to the affected area, because possible defatting of the skin or absorption of the solvent may result. Emergency showers with soap must be available where exposure may occur. Where contact with the eyes is likely, emergency eyewash stations should be provided.

Skin abnormalities with precancerous potential may result from exposure to PNA's. Employees must wash their hands and faces thoroughly with a suitable soap before leaving areas where PNA's are released as contaminants. Equipment and tools should be checked periodically for traces of PNA's, for example, with ultraviolet light [112].

Washrooms and showers should be provided in convenient locations, and employees should be urged to wash and shower after each work shift. To

minimize exposure time, whenever employees are exposed through skin contact they should be required to clean up immediately and change their work clothes.

Gloves, boots, aprons, goggles, face shields, and other personal protective devices should be made available for employee use. This equipment must be kept clean and in good condition. All personal protective equipment should be cleaned frequently, inspected regularly, and repaired or replaced as necessary. This equipment must be stored in appropriately designated containers or locations when not in use. Protective clothing must have all openings closed and fit snugly about the neck, wrists, and ankles whenever the wearer is in an exposure area. Clean work clothing should be put on before each work shift. At the end of the work shift, the employee should remove soiled clothing and shower before putting on street clothing. Street and work clothing should be separated within the change area. Clothing or other material should not be blown with air under pressure because of the potential generation of airborne dust. Soiled clothing should be deposited in a designated container and appropriately laundered before reuse.

Food should not be stored, prepared, dispensed (including vending machines), or eaten in workplaces where coal tar products are stored or used. Employees should exercise great care not to transfer material from contaminated gloves, garments, or respirators to the eyes, mouth, or skin. Lunchroom or lounge areas, if provided, should be separate from work areas and protected from contamination by coal tar products (29 CFR 1910.141).

In emergency operations or other operations where airborne concentrations are unknown, respiratory protection must be provided to

employees. Any employee assigned to an operation requiring respirator use should be examined to determine whether that employee is capable of performing the task while using the device. It is the employer's responsibility to inform the employee of the necessity of using a protective device when the air concentration of coal tar products cannot be kept at or below the limit. Respiratory protective devices must be kept clean and in good working order (29 CFR 1910.134). Respirators must be cleaned and inspected after each use. Cleanliness of respirators is particularly important because of the hazard associated with skin exposure to coal tar products. Respirators will often restrict the wearer's field of vision and perhaps mobility. This may pose additional safety hazards, so safety procedures appropriate to the job must be developed. Operations like roofing require these safety procedures, but other less hazardous operations need to be examined carefully to see what special procedures may be needed.

Spills and leaks of coal tar products must be cleaned up immediately, and employees engaged in cleanup must wear adequate personal protective garments and approved respiratory protective devices.

Spills of hot coal tar, coal tar pitch, or creosote may be covered with sand or other suitable mineral aggregate. When the absorbed material can be handled safely, it should be removed from the work area and may be disposed of in a suitable sanitary landfill. Storage facilities containing liquid or semisolid coal tar products shall be appropriately diked to contain emergency spills.

Wastes from coal tar products should not be flushed into a community sewer system unless such action will neither interfere with sewage

treatment nor violate applicable federal, state, or local regulations and ordinances regarding water contamination. Disposal or treatment of solid or liquid wastes must not result in prohibited or undesirable contamination of water, air, or land. The phenolic component of the waste water may be treated by either chemical or biological oxidation processes. The latter processes usually involve impounding the waste liquor, in which case precautions must be taken to ensure that seepage or effluent from the impoundment does not contaminate ground water or adjacent watercourses. Recycling spilled material back into the process should be considered when design changes are made. Diking and spill recovery systems should be part of the engineering control program.

Gaseous emissions can occur at loading and transfer points where heated coal tar products are handled. Exposure at such points should be minimized by installing fume and vapor control systems that reduce both personal exposure and atmospheric emissions. These systems must be checked and maintained periodically to ensure proper operation.

In all industries that handle coal tar products, written instructions informing employees of the particular hazards of the compounds, methods of handling the material, procedures for cleaning up spills, personal protective equipment requirements, and procedures for emergencies must be on file and readily available to employees. The employer must establish a program of instruction to familiarize all potentially exposed employees with these procedures. The Material Safety Data Sheet described in Appendix III should be used as a guide by employers in providing the necessary information, but this should be supplemented with specific instruction and training in work operations requiring employee contact with

coal tar products.

Good work practices, personal hygiene, and proper training of employees are necessary to control the occupational hazards associated with exposure to coal tar products. Employees must be thoroughly trained to use all procedures and equipment required in their employment and all appropriate emergency procedures and equipment. The effective use of good work practices and engineering controls depends on the knowledge and cooperation of employers and employees.