

criteria for a recommended standard....

**OCCUPATIONAL EXPOSURE
TO
COAL TAR PRODUCTS**



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PREFACE

The Occupational Safety and Health Act of 1970 emphasizes the need for standards to protect the health and safety of workers exposed to an ever-increasing number of potential hazards at their workplace. The National Institute for Occupational Safety and Health has projected a formal system of research, with priorities determined on the basis of specified indices, to provide relevant data from which valid criteria for effective standards can be derived. Recommended standards for occupational exposure, which are the result of this work, are based on the health effects of exposure. The Secretary of Labor will weigh these recommendations along with other considerations such as feasibility and means of implementation in developing regulatory standards.

It is intended to present successive reports as research and epidemiologic studies are completed and as sampling and analytical methods are developed. Criteria and standards will be reviewed periodically to ensure continuing protection of the worker.

I am pleased to acknowledge the contributions to this report on coal tar products by members of the NIOSH staff and the valuable constructive comments by the Review Consultants on Coal Tar Products, by the ad hoc committees of the American Occupational Medical Association and the American Conference of Governmental Industrial Hygienists, and by Robert B.

O'Connor, M.D., NIOSH consultant in occupational medicine. The NIOSH recommendations for standards are not necessarily a consensus of all the consultants and professional societies that reviewed this criteria document on coal tar products. A list of Review Consultants appears on page vi.



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The Division of Criteria Documentation and Standards Development, National Institute for Occupational Safety and Health, had primary responsibility for the development of the criteria and recommended standard for coal tar products. Earl S. Flowers, Ph.D., of this Division served as criteria manager during the initial phases of the document development, and Jack E. McCracken, Ph.D., served in this capacity during the later phases. SRI International (formerly Stanford Research Institute) developed the basic information for consideration by NIOSH staff and consultants under contract CDC-99-74-31.

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The views expressed and conclusions reached in this document, together with the recommendations for a standard, are those of NIOSH. These views and conclusions are not necessarily those of the consultants, other federal agencies or professional societies that reviewed the document, or of the contractor.

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CRITERIA DOCUMENT:
RECOMMENDATIONS FOR AN OCCUPATIONAL
EXPOSURE STANDARD FOR COAL TAR PRODUCTS

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I. RECOMMENDATIONS FOR A COAL TAR PRODUCTS STANDARD

The National Institute for Occupational Safety and Health (NIOSH) recommends that employee exposure to coal tar products in the workplace be controlled by adherence to the following sections. The standard is designed to protect the health and provide for the safety of employees for up to a 10-hour work shift, 40-hour workweek, over a working lifetime. Compliance with all sections of the standard should prevent or greatly reduce the adverse effects of coal tar products on the health and safety of employees. The standard is measurable by techniques that are valid, reproducible, and available to industry and government agencies. Sufficient technology exists to permit compliance with the recommended standard. The criteria and standard will be subject to review and revision as necessary.

These criteria and the recommended standard apply to exposure of employees to coal tar products. The term "coal tar products," as used in this recommended standard, includes coal tar and two of the fractionation products of coal tar, creosote and coal tar pitch, derived from the carbonization of bituminous coal. Coal tar, coal tar pitch, and creosote derived from bituminous coal often contain identifiable components which by themselves are carcinogenic, such as benzo(a)pyrene, benzanthracene, chrysene, and phenanthrene. Other chemicals from coal tar products such as anthracene, carbazole, fluoranthene, and pyrene may also cause cancer, but these causal relationships have not been adequately documented. "Occupational exposure to coal tar products" is defined as any contact with coal tar, coal tar pitch, or creosote in the work environment.

From the epidemiologic and experimental toxicologic evidence on coal tar, coal tar pitch, and creosote, NIOSH has concluded that they are carcinogenic and can increase the risk of lung and skin cancer in workers. Therefore, the permissible exposure limit recommended is the lowest concentration that can be reliably detected by the recommended method of environmental monitoring. While compliance with this limit should substantially reduce the incidence of cancer produced by coal tar products, no absolutely safe concentration can be established for a carcinogen at this time. The environmental limit is proposed to reduce the risk, and the employer should regard it as the upper boundary of exposure and make every effort to keep exposure as low as is technically feasible.

Section 1 - Environmental (Workplace Air)

(a) Concentration

Occupational exposure to coal tar products shall be controlled so that employees are not exposed to coal tar, coal tar pitch, creosote, or mixtures of these substances at a concentration greater than 0.1 milligram/cu m of the cyclohexane-extractable fraction of the sample, determined as a time-weighted average (TWA) concentration for up to a 10-hour work shift in a 40-hour workweek.

(b) Sampling and Analysis

Methods for sampling and analysis of coal tar products shall be as provided in Appendices I and II..

Section 2 - Medical

Medical surveillance shall be made available, as specified below, to all employees occupationally exposed to coal tar products.

(a) Preplacement medical examinations shall include:

(1) Comprehensive initial medical and work histories, with special emphasis directed toward identifying preexisting disorders of the skin, respiratory tract, liver, and kidneys.

(2) A physical examination giving particular attention to the oral cavity, skin, and respiratory system. This shall include posteroanterior and lateral chest X-rays (35 x 42 cm). Pulmonary function tests, including forced vital capacity (FVC) and forced expiratory volume at one second (FEV 1.0), and a sputum cytology examination shall be offered as part of the medical examination of exposed employees. Other tests, such as liver function and urinalysis should be performed as considered appropriate by the responsible physician. In addition, the mucous membranes of the oral cavity should be examined.

(3) A judgment of the employee's ability to use positive pressure respirators.

(b) Periodic examinations shall be made available at least annually. These examinations shall include:

(1) Interim medical and work histories.

(2) A physical examination as outlined in (a)(2) above.

(c) Initial medical examinations shall be made available to all workers as soon as practicable after the promulgation of a standard based on these recommendations.

(d) Pertinent medical records shall be maintained for all employees occupationally exposed to coal tar products, and such records shall be kept for at least 30 years after the termination of employment. These records shall be made available to the designated medical representatives of the Secretary of Health, Education, and Welfare, of the Secretary of Labor, of the employer, and of the employee or former employee. Employees or prospective employees with medical conditions, eg, acne rosacea, that may be directly or indirectly aggravated by exposure to coal tar products shall be counseled on the increased risk of impairment of their health from working with these substances.

Section 3 - Labeling and Posting

(a) All labels and warning signs shall be printed both in English and in the predominant language of non-English-reading workers. Illiterate workers and workers reading languages other than those used on labels and posted signs shall receive information regarding hazardous areas and shall be informed of the instructions printed on labels and signs.

(b) All containers of coal tar products shall bear the following label in addition to, or in combination with, label information required by other statutes, regulations, or ordinances:

COAL TAR PRODUCT
(Specify derivative if known)

HARMFUL TO THE SKIN, OR IF INHALED OR SWALLOWED
CAUSES BURNS OF EYES AND SKIN AND MAY CAUSE CANCER

Do not breathe dust, fume, or vapor.
Do not get in eyes, on skin, or on clothing.
Do not take internally.
Use only with adequate ventilation.
Wear goggles, face shield, gloves, and protective clothing
when handling.

In case of contact, immediately flush eyes with plenty of water
or skin with soap and water. Remove contaminated clothing and
shoes. Wash clothing before reuse. Call physician in case of
chemical or thermal burns.

(c) In all areas where there is occupational exposure to coal tar
products the following sign shall be posted in readily visible locations at
or near all entrances to the area and on or near all equipment used for
handling or containing coal tar products:

DANGER
CANCER HAZARD

AUTHORIZED PERSONNEL ONLY
COAL TAR PRODUCTS
IRRITATING TO SKIN AND EYES
NO SMOKING OR EATING

(d) If respirators are required for protection from coal tar
products, the following statement shall be added in large letters to the
sign required in Section 3(c):

RESPIRATOR REQUIRED

(e) In any workroom or area where there is likelihood of emergency situations arising from accidental skin, eye, or other exposures above the limit to coal tar products, signs required by Section 3(c) shall be supplemented, where applicable, to give additional information, such as emergency and first-aid instructions and procedures, the location of first-aid supplies and emergency equipment, including respiratory protective equipment, and the locations of emergency showers and eyewash fountains.

(f) The employer shall apply precautionary labels to all containers of protective clothing contaminated with coal tar products. The label shall bear the following legend:

CAUTION
CLOTHING CONTAMINATED WITH COAL TAR PRODUCTS
DO NOT REMOVE DUST BY BLOWING OR SHAKING

Section 4 - Personal Protective Equipment and Clothing

Employers shall use engineering controls when needed to keep the concentration of airborne coal tar products at or below the limit specified in Section 1(a). Employers shall provide protective clothing and equipment impervious to coal tar products to employees whenever liquid coal tar products may contact the skin or eyes. Emergency equipment shall be located at well-marked and clearly identified stations and shall be adequate to permit all personnel to escape from the area or to cope safely with the emergency on reentry.

(a) Eye and Face Protection

(1) Cup-type or rubber-framed chemical safety goggles shall be worn by employees engaged in activities in which coal tar products may come in contact with the eyes. When employees are exposed to airborne coal tar products at concentrations in excess of the limits specified in Section 1(a), a respiratory protective device with a full facepiece is required; this will also provide adequate eye protection as required by 29 CFR 1910.133.

(2) Full-length, plastic face shields (20-cm minimum) shall be worn, in addition to safety goggles, by employees working where contact with coal tar products is likely, except where full facepiece respirators are being worn.

(b) Protective Clothing

(1) Employers shall provide, and shall require employees working with creosote to wear, gloves, protective sleeves, aprons, jackets, trousers, caps, and shoes as necessary to prevent skin contact with creosote. These garments shall be made of a material resistant to penetration by creosote, such as polychloroprene, polyethylene, rubber, or other suitable material.

(2) Employers shall provide, and shall require employees working with creosote to wear, suitable clothing to prevent skin contact with coal tar. These garments shall be made of a material resistant to penetration by coal tar. For employees working with heated coal tar pitch, employers shall require use of protective clothing sufficient to prevent skin contact.

(3) Employees handling drums, cans, or other large containers of coal tar products shall wear impervious shoes or boots with safety toe-caps. Leather safety shoes shall be protected from splashes or spills by impervious coverings such as rubbers.

(4) The employer shall ensure that, at the completion of the work shift, all protective clothing is removed only in the change rooms prescribed in Section 7.

(5) The employer shall ensure that contaminated protective clothing that is to be cleaned, laundered, or disposed of is placed in a closed container in the change room.

(c) Respiratory Protection

(1) Engineering controls shall be used when needed to keep air concentrations of airborne coal tar products at or below the limits specified in Section 1(a). Respiratory protective equipment may be used in the following circumstances:

(A) During the time necessary to install or test the required engineering controls.

(B) For operations, such as nonroutine maintenance and repair activities, in which brief exposures at concentrations in excess of the concentration limit in Section 1(a) may occur.

(C) During emergencies when concentrations of airborne coal tar products might exceed the concentration limit in Section 1(a).

(2) When a respirator is permitted by paragraph (c)(1) of this section, it shall be selected and used in accordance with the following requirements:

(A) The employer shall establish and enforce a respiratory protective program. The requirements for such a program are listed in 29 CFR 1910.134.

(B) The employer shall provide respirators in accordance with Table I-1 and shall ensure that employees use the respirators properly when the concentration of airborne coal tar products exceeds the concentration limit in Section 1(a). The respirators shall be those approved by NIOSH or the Mining Enforcement and Safety Administration. The standard for approval is specified in 30 CFR 11. The employer shall ensure that respirators are properly cleaned, maintained, and stored when not in use.

(C) Protective equipment suitable for emergency entry shall be located at clearly identified areas outside the work area.

TABLE I-1

RESPIRATOR SELECTION GUIDE FOR COAL TAR, COAL TAR PITCH, AND CREOSOTE

Particulate and Vapor Concentration	Respirator Type Approved under Provisions of 30 CFR 11
Greater than 0.1 mg/cu m cyclohexane extractable or entry into unknown concentrations	(1) Self-contained breathing apparatus with full facepiece operated in pressure-demand or other positive pressure mode (2) Combination respirator that includes Type C supplied-air respirator and full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode
Firefighting	Self-contained breathing apparatus with full facepiece operated in pressure-demand or other positive pressure mode

Section 5 - Informing Employees of Hazards from Coal Tar Products

(a) At the beginning of employment or assignment for work that may involve exposure to coal tar products in the occupational environment, the employer shall inform each employee of the hazards of such employment and of the possible injuries resulting from exposure to coal tar products. The employee shall be instructed in the proper procedures for safe handling and use of coal tar products, in the operation and use of protective systems and devices, and in appropriate emergency procedures.

(b) Employers shall institute a continuing education program, conducted by persons qualified by experience or special training, to ensure that all employees have current knowledge of job hazards, proper maintenance procedures, cleanup methods, and correct use of respirators.

The instructional program shall include a description of the medical and environmental surveillance procedures and the advantage to the employee of participation in these procedures.

(c) Required information shall be recorded on a "Material Safety Data Sheet" described in Appendix III or on a similar form approved by the Occupational Safety and Health Administration, US Department of Labor. This information shall also be made available in the work area and kept on file, readily accessible to employees at any place of employment where exposure may occur.

Section 6 - Work Practices

(a) Spills and leaks of creosote shall be cleaned up immediately. Employees engaged in cleanup operations shall wear suitable protective clothing, equipment, and respiratory devices. Spills and leaks of other coal tar products shall be cleaned up after allowing necessary time for cooling. Employees instructed and trained in the procedures for safe decontamination or disposal of equipment, materials, and waste shall perform or directly supervise cleanup operations. All other persons shall be excluded from the area of the spill or leak until cleanup is complete and safe conditions have been restored.

(b) Equipment and systems for using, handling, or transferring coal tar products shall be enclosed to the greatest extent feasible for the operation or shall otherwise be designed or controlled to prevent skin or eye contact with and minimize exposure to airborne coal tar products.

(c) Coal tar products shall be stored in covered or closed containers in areas that are adequately ventilated so that airborne coal

tar products concentrations do not exceed the limit specified in Section 1(a).

(1) Storage conditions shall be controlled to prevent overheating and pressure buildup in containers of coal tar products. Transfer and storage systems shall be designed and operated to prevent blockage by condensed coal tar products.

(2) Smoking and the use of open flames shall be prohibited when heat is applied to melt coal tar products. When coal tar products are transferred by a pressure system to storage, to shipping containers, or to pressure vessels, transfer conditions shall be controlled to prevent splashes and excessive pressure in the system.

(3) Bulk storage facilities shall be designed and constructed to contain any leaks or spills.

(4) Storage containers and transfer lines shall be maintained in good condition.

(5) Drums, carboys, or other containers of coal tar products shall be closed while they are being moved or handled. Material from these containers shall be transferred carefully to prevent splashes, spills, or other circumstances by which employees may come into contact with coal tar products.

(6) Leaking containers shall be isolated in adequately ventilated areas, or the coal tar products contained therein shall be transferred to an intact container. Employees performing such operations shall wear appropriate personal and respiratory protective equipment.

(7) Shipping containers to be recycled shall be completely drained and securely sealed. Coal tar products shall be cleaned from the

outside surfaces of these containers.

(8) Coal tar products shall be transferred to or from tank trucks, cars, or other vessels only at facilities designed and designated for such operations. The wheels of the tank vehicle shall be chocked, and vessels shall be secured. Warning signs shall be displayed, and barriers shall be erected to prohibit entry of unauthorized personnel. Connections of the tank and the transfer system shall be compatible and clearly identified. Only trained, authorized persons may carry out the procedures.

(A) No transfer shall be made unless authorized by a responsible supervisor.

(B) Open flames and smoking shall be prohibited in the area during transfer operations.

(C) The tank car or truck shall be electrically grounded and bonded to the transfer line and receiving tank.

(D) Employees engaged in sampling shall wear appropriate respiratory and full-body protective equipment to limit exposure.

(E) Leaks or spills shall be cleaned up immediately.

(d) Tanks, process equipment, and lines shall be cleaned, maintained, or repaired only by properly trained employees under responsible supervision. When possible, such work shall be accomplished from the outside of the tank or equipment. Entry into confined spaces, such as tanks, pits, tank cars, barges, process vessels, and tunnels, shall be controlled by a permit system. Such permits shall be issued by an authorized representative of the employer, certifying that preparation of the confined space, precautionary measures, and personal protective

equipment are adequate, and that prescribed procedures have been followed.

(1) Drainage or flushings contaminated with coal tar products shall be drained to a coal tar products waste system, and employees shall avoid contact with them.

(2) Ventilation shall be sufficient to maintain a safe environment for employees working in confined spaces, ie, that there is an adequate supply of oxygen. Concentrations of airborne coal tar products and other air contaminants shall be monitored while employees are in the confined space to ensure that they are not exposed at concentrations in excess of the limit specified in Section 1(a).

(3) No employee shall enter any tank or vessel that does not have an entrance large enough to admit an employee equipped with safety harness, lifeline, and appropriate respiratory equipment. The employee shall be able to leave the tank or vessel by the same opening.

(4) Employees entering contaminated tanks or vessels shall wear full-body protective clothing until inspection and testing assure safety for personnel in the tank.

(5) When employees are working in confined spaces, another employee shall be stationed at the entrance to keep them under constant observation, and one or more additional employees shall be readily available in case of an emergency. A positive pressure respiratory protective device with safety harness and lifeline shall be located outside the tank or vessel for emergency use.

(6) Before work in or on any tank, line, or equipment commences, engineering provisions shall be made for preventing inadvertent entry of coal tar products into the work area.

(7) Exterior work on a tank, vent, or equipment that may lead to leaking or ignition of coal tar products shall be prohibited until the equipment has been cleaned of combustible materials.

(e) Waste or other materials contaminated with coal tar products shall be treated or disposed of so that workers will not inhale, ingest, or have skin contact with such materials or so that water supplies will not be contaminated. Because of possible generation of airborne coal tar products, sanitary landfill should be used for disposal rather than burning.

(f) Emergency showers and eyewash fountains shall be provided at locations readily accessible to all areas where coal tar products may contact the skin or eyes.

(g) Protective clothing, respirators, goggles, and other personal protective gear that has been contaminated by coal tar products shall be thoroughly washed or cleaned before reuse by any employee. Persons who launder or clean contaminated protective equipment shall be advised of the hazards associated with handling such equipment and of procedures needed to prevent these hazards. Contaminated shoes increase the risk of skin contact with coal tar products and shall be decontaminated or discarded. Employers shall ensure that all protective equipment is regularly inspected and maintained and that damaged items are repaired or replaced.

(h) The employer shall designate all areas where there is occupational exposure to coal tar products as regulated areas. Only properly trained and authorized employees are allowed in such areas. Daily rosters shall be made of all persons who enter regulated areas.

(i) The employer shall develop emergency plans and procedures and shall train employees to implement the plans effectively.

(1) Emergency procedures shall be reviewed periodically with employees, and written descriptions of the procedures shall be made available in work areas.

(2) Appropriate emergency equipment, including protective clothing and respiratory protective devices for rescue, shall be located in a safe area adjacent to areas where overexposure to coal tar products might occur.

(3) During emergencies, all personnel except trained and properly equipped emergency teams shall be evacuated from the area.

(j) The employer shall take necessary steps to ensure that all employees are adequately trained in emergency procedures.

(1) Each employee shall receive instruction and training in safe work practices and emergency procedures and in the proper use of operational equipment and protective devices.

(2) Each employee shall receive refresher sessions and drills, at least annually, in safe work practices and emergency procedures.

(3) Each employee shall be informed of the locations of all emergency and first-aid equipment and supplies in the work area.

(4) Each employee shall be informed of the need to report any emergency, exposure, or injury, to the supervisor.

Section 7 - Sanitation

(a) Eating and food preparation or dispensing (including vending machines) shall be prohibited where there is occupational exposure to coal tar products.

(b) Smoking shall be prohibited in areas where coal tar products are present.

(c) Employees who handle coal tar products or equipment contaminated with coal tar products shall be instructed to wash their hands thoroughly with soap or mild detergent and water before using toilet facilities or eating.

(d) To prevent skin absorption of coal tar products, employers shall instruct employees not to use solvents to clean their hands.

(e) The employer shall provide clean change rooms equipped with storage facilities for street clothes and separate storage facilities for protective clothing and equipment whenever employees are required to wear protective clothing and equipment in accordance with Section 4.

Section 8 - Monitoring and Recordkeeping

(a) Monitoring

(1) As soon as practicable after promulgation of a standard based on these recommendations, each employer who has a place of employment in which there is occupational exposure to coal tar products shall institute a program of personal monitoring to measure or permit calculation of the exposure of all employees.

(A) In all personal monitoring, samples representative of the breathing zone of the employee shall be collected.

(B) For each determination of the concentration at which an employee is exposed to airborne coal tar products, a sufficient number of samples shall be taken to characterize the employee's exposure during each work shift. Variations in work and production schedules and in employees' locations and job functions shall be considered in choosing sampling times, locations, and frequencies.

(C) Each operation in each work area shall be sampled at least once every 3 months.

(2) If an employee is found to be exposed to airborne coal tar products at concentrations in excess of the limit specified in Section 1(a), the exposure of that employee shall be measured at least once a week, control measures shall be initiated, and the employee shall be notified of the extent of the exposure and of the control measures being implemented to reduce the concentration of airborne coal tar products to or below the limit specified in Section 1(a). Such monitoring shall continue until two consecutive determinations, at least 1 week apart, indicate that the employee is no longer exposed to airborne coal tar products at concentrations greater than the limit specified in Section 1(a). Routine monitoring may then be resumed.

(b) Recordkeeping

Records of personal monitoring shall be kept for the duration of employment and for at least 30 years after the employee's last occupational exposure to coal tar products. These records shall include the dates and times of measurements, job function and location of employees within the

worksite, methods of sampling and analysis used, types of respiratory protective devices in use at the time of sampling, concentrations of airborne coal tar products found, and identification of exposed employees. Employees shall be allowed to obtain information on their own environmental exposures. Daily rosters of authorized persons who enter regulated areas shall be retained for at least 30 years. Environmental monitoring records and entry rosters shall be made available to designated representatives of the Secretary of Labor and of the Secretary of Health, Education, and Welfare.

Each employee's medical records should include records of environmental exposures applicable to that employee. These records shall be retained for 30 years after the employee's last occupational exposure to coal tar products. These medical records shall be made available to the designated medical representatives of the Secretary of Labor, of the Secretary of Health, Education, and Welfare, of the employer, and of the employee or former employee.

II. INTRODUCTION

This report presents the criteria and the recommended standard based thereon that were prepared to meet the need for preventing occupational diseases and injuries arising from exposure to coal tar products. The criteria document fulfills the responsibility of the Secretary of Health, Education, and Welfare, under Section 20(a)(3) of the Occupational Safety and Health Act of 1970 to "...develop criteria dealing with the toxic materials and harmful physical agents and substances which will describe...exposure levels at which no employee will suffer impaired health or functional capacities or diminished life expectancy as a result of his work experience."

The National Institute for Occupational Safety and Health (NIOSH), after a review of data and consultation with others, formalized a system for the development of criteria upon which standards can be established to protect the health and to provide for the safety of employees exposed to hazardous chemical and physical agents. Criteria for a recommended standard should enable management and labor to develop better engineering or administrative controls resulting in more healthful work environments, and simply complying with the recommended standard should not be regarded as a final goal.

These criteria and the recommended standard for coal tar products are part of a continuing series of documents published by NIOSH. The proposed standard applies to the processing, manufacture, and use of coal tar products as applicable under the Occupational Safety and Health Act of 1970. The standard is not designed for the population-at-large, and any

extrapolation beyond the occupational environment is not warranted. It is intended to (1) protect against injury from coal tar products, (2) be measurable by techniques that are valid, reproducible, and available to industry and government agencies, and (3) be attainable with existing technology.

Based on a review of the toxicologic and epidemiologic evidence presented, it has been concluded that some materials contained in coal tar pitch, and therefore in coal tar, can cause lung and skin cancer, and perhaps cancer at other sites. Based on a review of experimental toxicologic evidence, it is also concluded that creosote can cause skin and lung cancer. While the evidence on creosote is not so strong as that on pitch (in part because of difficulties in chemical characterization of such mixtures), the conclusion on the carcinogenic potential of creosote is supported by information on the presence of polynuclear aromatic hydrocarbons and imputations and evidence of the carcinogenicity of such hydrocarbons.

Historically, coal tar pitch exposures have been monitored by extracting samples with benzene. This has advantages in dealing with complex mixtures, but fails to identify the exact nature of airborne exposures to pitches and other coal tar products. Until better methods are developed, NIOSH proposes to continue this monitoring scheme. However, because of the great hazards from exposure to benzene at low concentrations, it is recommended that exposure to benzene be minimized to the extent possible. Because existing controls in laboratories, eg, fume hoods, are likely to be insufficient to control benzene to the extent necessary, it is proposed that cyclohexane be used as the solvent for

extracting coal tar products in the analytical procedure. Whether cyclohexane will extract carcinogenic substances in coal tar efficiently, thus whether cyclohexane extraction procedures are as efficient as benzene extraction procedures in monitoring exposure to coal tar products, needs experimental determination. After such determination, a solvent other than cyclohexane, conceivably even benzene, may be recommended.

As with other carcinogenic substances, NIOSH recommends a permissible exposure limit based on the sensitivity of the monitoring method. Because the sampling and analytical method selected for monitoring coal tar products has limited sensitivity, it is necessary that personal sampling be performed to filter at least 750 liters of air, eg, for 8 hours at a flowrate of at least 1.56 liters/minute, to collect a sufficient quantity, 75 μ g, of coal tar products. This will allow reliable analysis at the workplace environmental limit specified in Section 1(a) of Chapter I. If the analytical method is refined further, resulting in an increase in the sensitivity, it is suggested that sampling time be lowered in order to limit to the extent possible exposures above 0.1 mg/cu m.