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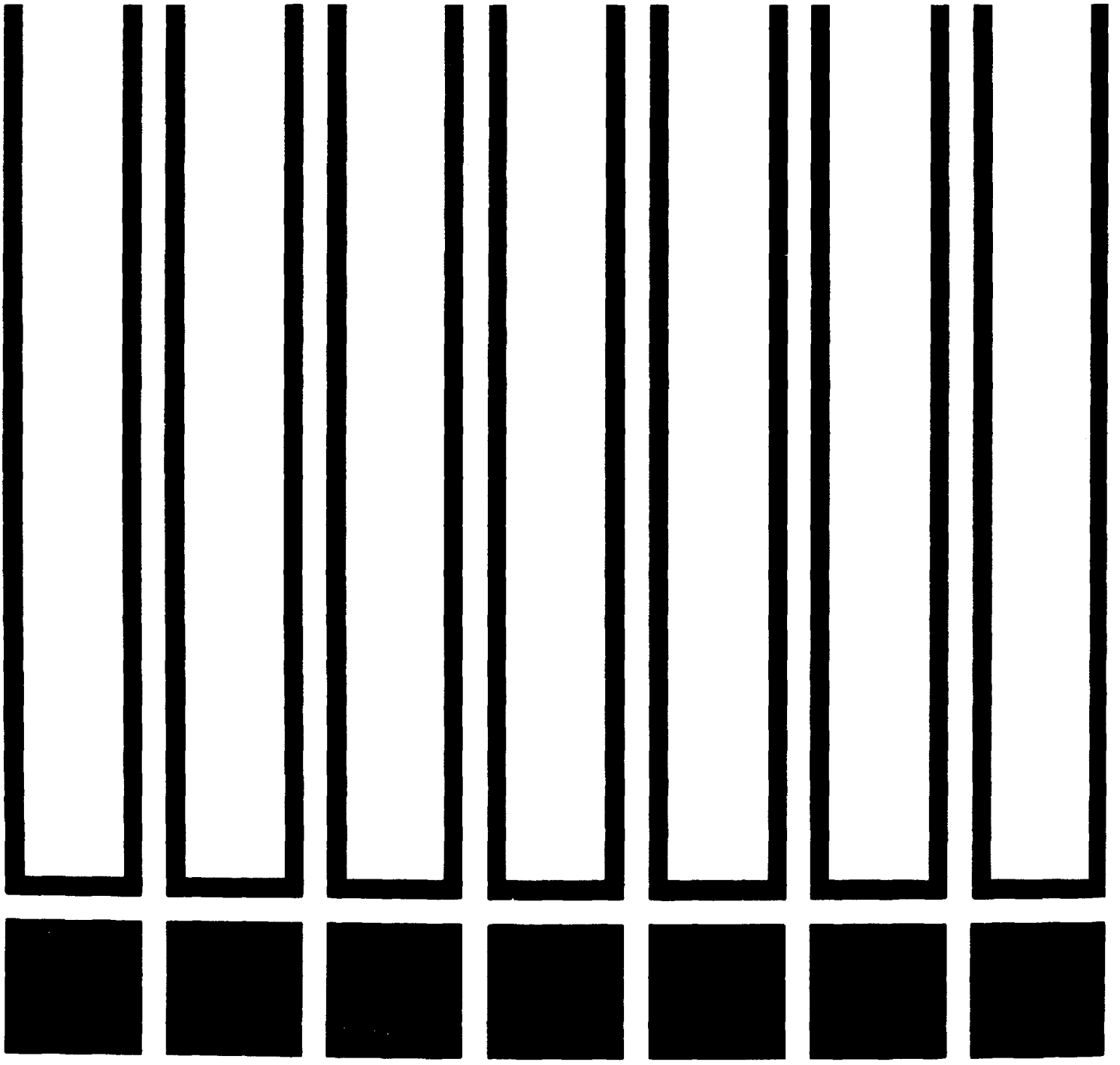

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service Center for Disease Control
National Institute for Occupational Safety and Health

criteria for a recommended standard....

OCCUPATIONAL EXPOSURE TO ASPHALT FUMES

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
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National Institute for Occupational Safety and Health
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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 asphalt fumes by members of the NIOSH staff and the valuable constructive comments by the Review Consultants on Asphalt Fumes, by the ad hoc committees of the Society of Toxicology and the American Academy of Industrial Hygiene, 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 asphalt fumes. 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 asphalt fumes. Craig R. McCormack of this Division served as criteria manager. SRI International developed the basic information for consideration by NIOSH staff and consultants under contract CDC 99-74-31.

The Division review staff for this document consisted of Richard A. Rhoden, Ph.D. (Chairman), Paul E. Caplan, J. Henry Wills, Ph.D., Thomas L. Anania, Division of Surveillance, Hazard Evaluations, and Field Studies, Loren L. Hatch, D.O., Division of Technical Services, Richard W. Niemeier, Ph.D., Division of Biomedical and Behavioral Science, and Seymour D. Silver, Ph.D.

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 and professional societies that reviewed the document, or of the contractor.

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CRITERIA DOCUMENT:
RECOMMENDATIONS FOR AN OCCUPATIONAL
EXPOSURE STANDARD FOR ASPHALT FUMES

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I. RECOMMENDATIONS FOR AN ASPHALT FUMES STANDARD

The National Institute for Occupational Safety and Health (NIOSH) recommends that employee exposure to asphalt fumes 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 adverse effects of asphalt fumes on the health of employees and provide for their safety. The standard is measurable by techniques that are valid, reproducible, and available to industry and governmental agencies. Sufficient technology exists to permit compliance with the recommended standard. Although the workplace occupational exposure limit is considered to be a safe level based on current information, it should be regarded as the upper boundary of exposure and every effort should be made to maintain exposure at a level as low as is technically feasible. The criteria and standard will be subject to review and revision as necessary.

The principal adverse effects on health from exposure to asphalt fumes are irritation of the serous membranes of the conjuctivae and the mucous membranes of the respiratory tract. Hot asphalt can cause burns of the skin. In animals, there is evidence that asphalt left on the skin for long periods of time may result in local carcinomas, but there have been no reports of such effects on human skin that can be attributed to asphalt alone. No reliable reports of malignant tumors of parenchymatous organs due to exposure to asphalt fumes have been found, but there has been no

extensive study of this possible consequence of occupational exposure in the asphalt industry.

Asphalt fumes are defined as the cloud of small particles created by condensation from the gaseous state after volatilization of asphalt. Approximately 96% of the asphalt used in this country is used in paving and roofing operations. "Occupational exposure" to asphalt fumes is defined as exposure in the workplace at a concentration of one-half or more of the recommended occupational exposure limit. If exposure to other chemicals also occurs, as is the case when asphalt is mixed with a solvent, emulsified, or used concurrently with other materials such as tar or pitch, provisions of any applicable standard for the other chemicals shall also be followed.

A gravimetric method is recommended for estimation of the air concentration of asphalt fumes. When large amounts of dust are present in the same atmosphere in which the asphalt fume is present, which may occur in road-building operations, the gravimetric method may lead to erroneously high estimates for asphalt fumes, and to possibly undeserved sanctions and citations for ostensibly exceeding the environmental limit for asphalt fumes or nuisance particulates. NIOSH recommends that where the resolution of such problems becomes necessary, a more specific procedure, which involves solvent extraction and gravimetric analysis, be employed for the determination of asphalt fumes. The best procedure now available seems to be ultrasonic agitation of the filter in benzene and weighing of the dried residue from an aliquot of the clear benzene extract. NIOSH is attempting to devise an even more specific method for asphalt fumes for use under such conditions.

It is possible, but not proven, that benzene can be replaced without loss of extraction efficiency by other solvents, including cyclohexane.

IF BENZENE IS USED, THE FACT THAT NIOSH REGARDS THIS CHEMICAL AS A VIRTUAL CARCINOGEN SHOULD BE KEPT IN MIND. PRECAUTIONS SHOULD BE TAKEN TO PREVENT EXPOSURE OF ANALYTIC AND OTHER PERSONNEL TO SIGNIFICANT AMOUNTS OF BENZENE AS EITHER LIQUID OR VAPOR. 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 constituents of asphalt in the analytical procedure. Whether cyclohexane will extract these constituents efficiently, ie, whether cyclohexane extraction procedures are as efficient as benzene extraction procedures in monitoring exposure to asphalt fumes, needs to be determined experimentally. If the procedures are found to be inefficient, a solvent other than cyclohexane, conceivably even benzene, may be recommended.

When mineral dusts are present in comparatively high amounts on the sampling filters, the possible contributions of silica dust and asbestos microfibers to pulmonary disease should be remembered and appropriate steps taken to minimize the exposure of employees to such dusts.

The small number of papers reporting a biologic hazard from exposure to asphalt fumes has not allowed a determination of the concentration threshold that produces adverse effects. Because of the presence of minute quantities of neoplastigenic hydrocarbons in some asphalts, NIOSH believes that asphalt fumes should be considered to be somewhat more hazardous than a nuisance dust. Accordingly, a ceiling concentration limit numerically

equivalent to the current US occupational exposure limit for respirable nuisance particulate is recommended.

Section 1 - Environmental (Workplace Air)

(a) Concentration

Occupational exposure to asphalt fumes shall be controlled so that employees are not exposed to the airborne particulates at a concentration greater than 5 milligrams per cubic meter of air (mg/cu m), determined during any 15-minute period.

(b) Sampling and Analysis

Occupational environmental samples shall be collected and analyzed as described in Appendices I and II or III, or by any method shown to be equivalent in accuracy, precision, and sensitivity to the methods specified.

Section 2 - Medical

Medical surveillance shall be made available as outlined below to all workers subject to occupational exposure to asphalt fumes.

(a) Preplacement examinations shall include at least:

(1) Comprehensive medical and work histories with special emphasis directed towards the eye, skin, and respiratory system.

(2) Physical examination giving particular attention to evidence of abnormalities in the eyes, skin, or respiratory system.

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

(b) Periodic examinations shall be made available at a frequency to be determined by the responsible physician. These examinations shall include at least:

(1) Interim medical and work histories.

(2) Physical examination as outlined in (a)(2) above.

(c) During examinations, applicants or employees found to have medical condtions which would be directly or indirectly aggravated by exposure to asphalt fumes shall be counseled on the increased risk of impairment of their health by working with this substance.

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

(e) In the event of illness known or suspected to be due to asphalt fumes, a physical exmaination shall be made available.

(f) Pertinent medical records shall be maintained for all employees exposed to asphalt fumes in the workplace. Such records shall be kept for at least 30 years after 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.

Section 3 - Labeling and Posting

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 the labels and signs.

(a) Labeling

The following labels shall be affixed in a readily visible position on all tanks and containers of hot asphalt:

HOT ASPHALT

WARNING!
MAY CAUSE SEVERE BURNS

Do not get in eyes or on skin.
Use only with adequate ventilation.
Wear safety glasses, face shield, gloves, and protective clothing when handling.

First Aid: Call a physician as quickly as possible. In case of contact with eyes, immediately flush eyes with plenty of water for at least 15 minutes. In case of contact with skin, immerse affected part in cold water. If ice is available, pack ice on the asphalt adhering to the skin or apply an emergency cold pack. If difficulty in breathing occurs after inhalation, remove victim to fresh air and keep warm and quiet. If breathing stops, give artificial respiration.

The following labels shall be affixed in a readily visible position on all tanks and containers of cold liquid asphalt:

(*ASPHALT)

WARNING!
HARMFUL IF SWALLOWED
MAY BE IRRITATING TO SKIN AND EYES

Do not get in eyes or on skin.
Do not take internally.
Use only with adequate ventilation.
Wear safety glasses, face shield, gloves, and protective clothing when handling.

First Aid: Call a physician as quickly as possible. In case of contact with eyes, flush eyes immediately with plenty of water for at least 15 minutes. In case of contact with skin, wash affected area with detergent and water. If swallowed, give milk or olive oil. DO NOT INDUCE VOMITING.

*Insert CUT-BACK or EMULSIFIED, whichever is appropriate

(b) Posting

(1) The following warning sign shall be posted in readily visible locations at or near all entrances to areas where asphalt fumes are generated, and on or near all equipment generating asphalt fumes:

WARNING!
ASPHALT FUMES EXPOSURE AREA

HIGH CONCENTRATIONS OF FUMES MAY
CAUSE NOSE AND EYE IRRITATION

FIRE HAZARD

(2) If respirators are required for protection from asphalt fumes, the following statement shall be added in large letters to the sign required in Section 3(b):

RESPIRATORY PROTECTION REQUIRED IN THIS AREA

(3) In any workroom or area where it is likely that emergency situations will arise from accidental skin or eye contact or other excessive exposure to asphalt or asphalt fumes, signs required by Section 3(b) shall be supplemented by additional signs giving emergency and first-aid instructions and procedures and the location of first-aid supplies and emergency equipment, including respiratory protective equipment.

Section 4 - Personal Protective Equipment and Clothing

(a) Respiratory Protection

(1) Engineering controls shall be used when needed to keep concentrations of asphalt fumes below the recommended exposure limit. The

only conditions under which compliance with the recommended exposure limit may be achieved by the use of respirators are:

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

(B) For operations such as nonroutine maintenance or repair activities causing brief exposure at concentrations above the environmental limit.

(C) During emergencies when concentrations of asphalt fumes may exceed the environmental limit.

(2) When a respirator is permitted by paragraph (a)(1) of this section, it shall be selected from a list of respirators approved under 30 CFR 11 and used in accordance with the following requirements:

(A) The employer shall establish and enforce a respiratory protective program meeting the requirements of 29 CFR 1910.134.

(B) When employees are exposed above the recommended limit, the employer shall provide respirators in accordance with Table I-1 and shall ensure that the employees use the respirators provided.

(C) Respirators specified for use in higher concentrations of asphalt fumes may be used in atmospheres of lower concentrations.

(D) The employer shall ensure that respirators are adequately cleaned and maintained and that employees are instructed and drilled at least annually in the proper use and testing for leakage of respirators assigned to them.

TABLE I-1

RESPIRATOR SELECTION GUIDE FOR ASPHALT FUMES

Concentration (mg/cu m)	Respirator Type Approved under Provisions of 30 CFR 11
Less than or equal to 25	(1) Single-use dust respirator or quarter-mask dust respirator (2) Supplied-air respirator operated in demand mode (negative pressure) equipped with quarter-mask facepiece
Less than or equal to 50	(1) Half-mask facepiece dust respirator (2) Supplied-air respirator operated in demand mode (negative pressure) equipped with half-mask facepiece, or supplied-air respirator operated in continuous-flow mode equipped with half-mask facepiece
Greater than 50 or for emergency entry such as firefighting	Self-contained breathing apparatus operated in pressure-demand or other positive pressure mode

(E) Respirators shall be easily accessible, and employees shall be informed of their location.

(F) When a self-contained breathing apparatus is used in atmospheres with asphalt fumes concentrations greater than 50 mg/cu m, standby workers with suitable rescue and communications equipment must be present as provided in Section 6(b)(4).

(b) Protective Clothing

Employees shall wear appropriate protective clothing, including gloves, suits, boots, face shields (8-inch minimum), or other clothing as needed, to prevent eye and skin contact with asphalt.

Section 5 - Informing Employees of Hazards from Molten Asphalt and Asphalt Fumes

(a) The employer shall provide to the employee at the beginning of employment and on a periodic basis thereafter information concerning hazards, relevant symptoms of overexposure, appropriate emergency procedures, and proper conditions and precautions necessary to minimize exposure to molten asphalt and asphalt fumes. Employees shall be provided with up-to-date information whenever there is a process change. Records of such training shall be kept to verify the frequency of training, and each employee shall be advised of the availability of such information, which shall include that prescribed in paragraph (b) of this section and shall be accessible to the worker at each establishment or department where asphalt fumes may be generated.

(b) Required information shall be recorded as specified in Appendix IV, "Material Safety Data Sheet," or on a similar form approved by the Occupational Safety and Health Administration, US Department of Labor.

Section 6 - Work Practices

(a) Emergency Procedures

For all work areas in which there is a potential for emergencies involving asphalt fumes, the procedures specified below, as well as any other procedures appropriate for a specific operation or process, shall be formulated in advance, and employees shall be instructed in their implementation.

(1) Procedures shall include prearranged plans for obtaining emergency medical care and for necessary transportation of

injured workers. Employees shall also be trained in administering immediate first aid and shall be prepared to render such assistance when necessary.

(2) Personnel essential to emergency operations shall use approved skin and respiratory protection as specified in Section 4.

(3) Employees not essential to emergency operations shall be evacuated from exposure areas during emergencies. Perimeters of hazardous exposure areas shall be delineated, posted, and secured.

(4) All persons who may be required to shut off sources of asphalt fumes and to repair leaks shall be properly trained in emergency procedures and adequately protected against the attendant hazards from exposure to asphalt fumes.

(b) Confined Spaces

(1) Entry into confined spaces, such as tanks, process vessels, and tunnels, shall be controlled by a permit system. Permits signed by an authorized representative of the employer shall certify that preparation of the confined space, precautionary measures, and personal protective equipment are adequate and that precautions have been taken to ensure that prescribed procedures will be followed.

(2) Confined spaces that have previously contained asphalt fumes shall be inspected and tested for the presence of asphalt fumes and the temperature shall be measured prior to entry.

(3) Confined spaces shall be ventilated while work is in progress to keep the concentrations of asphalt fumes and other air contaminants below the workplace occupational exposure limits and to assure an adequate supply of oxygen. Air from the confined spaces shall be

ventilated to a point remote from any work area. When ventilation is inadequate to maintain the concentration of asphalt fumes and other air contaminants below the recommended occupational exposure limits, respiratory protective equipment shall be used in accordance with the provisions of Table I-1.

(4) Any individual entering confined spaces where the concentration of asphalt fumes may exceed 50 mg/cu m or where other air contaminants are excessive shall wear a suitable harness with lifelines tended outside the space by another employee who shall also be equipped with the necessary protective equipment, including a self-contained breathing apparatus that operates in the pressure-demand (positive pressure) mode. Communication (visual, voice, signal line, telephone, radio, or other suitable means) with the employee inside the enclosed space shall be maintained by the standby person.

(c) Engineering Controls

Engineering controls, such as local exhaust ventilation, shall be used to keep concentrations of asphalt fumes and other air contaminents below the recommended occupational exposure limits and to provide oxygen. Powered ventilation systems shall be designed to prevent the accumulation of asphalt fumes in the workplace. Ventilation systems shall be subject to regular preventive maintenance and cleaning to ensure maximum effectiveness (which shall be verified by periodic airflow measurements) and prevent the occurrence of fires in the accumulated asphalt. The system efficiency measurements shall also be made within 5 workdays of any change in production or control equipment that might result in an increase in the concentrations of asphalt fumes. Before maintenance work on control

equipment begins, sources of asphalt fumes shall be eliminated to the extent feasible. If concentrations below the recommended occupational exposure limits cannot be assured, respiratory protective equipment as specified in Table I-1 shall be used during nonroutine maintenance work. The employer shall ensure that the required measurements are performed by technically qualified persons.

Section 7 - Sanitation Practices

(a) Eating and food preparation or dispensing (including vending machines) shall be prohibited in the immediate area of asphalt use or where asphalt fumes are present.

(b) Smoking shall be prohibited in the immediate area of asphalt use or where asphalt fumes are present.

(c) Employees who handle asphalt or who work in an area where they are exposed to asphalt fumes shall be instructed to wash their hands with nonvolatile skin cleaners and water before drinking, eating, smoking, or using toilet facilities.

Section 8 - Monitoring and Recordkeeping

Workers shall not be considered occupationally exposed to asphalt fumes if environmental concentrations, as determined on the basis of an industrial hygiene survey conducted as soon as practicable after the promulgation of a standard based on these recommendations, do not exceed one-half the recommended occupational exposure limit. Records of these surveys, including the basis for concluding that air levels are at or below

this limit, shall be kept. Surveys shall be repeated at least once every 3 years and within 30 days after any process change likely to result in an increased concentration of asphalt fumes.

If it has been determined that environmental concentrations of asphalt fumes may exceed one-half the recommended occupational exposure limit, the following requirements apply:

(a) Personal Monitoring

(1) A program of personal monitoring shall be instituted to identify and measure, or permit calculation of, the exposure of all employees occupationally exposed to asphalt fumes.

(2) Routine monitoring of occupationally exposed employees shall be conducted at least annually.

(3) If monitoring of an employee's exposure to asphalt fumes reveals an exposure in excess of the recommended ceiling concentration limit, control measures shall be initiated, the exposure of that employee shall be measured at least every 30 days, the employer shall ensure that the employee is protected by a respirator, and the employee shall be notified of the exposure and of the control measures being implemented. Such monitoring shall continue until two consecutive determinations, at least a week apart, indicate that the employee's exposure no longer exceeds the recommended environmental limit. Routine monitoring may then be resumed.

(4) In all personal monitoring, samples representative of the exposure in the breathing zone of the employee shall be collected. Procedures for sampling, calibration of equipment, and analysis of samples of air for asphalt fumes shall be in accordance with Section 1(b).

(5) For each determination of an occupational exposure concentration, 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 the employee's location and job functions shall be considered when samples are collected.

(b) Recordkeeping

Employers or their successors shall keep records of environmental monitoring for each employee for at least 30 years after the individual's employment has ended. These records shall include the name and social security number of the employee being monitored, duties and job locations within the worksite, dates of measurements, sampling and analytical methods used and evidence for their accuracy, duration of sampling, number of samples taken, results of analyses, occupational exposure concentrations based on these samples, and any personal protective equipment used by the employee. Records for each employee, indicating date of employment with the company and changes in job assignment, shall be kept for the same 30-year period. The employer shall make these records available upon request to authorized representatives of the Assistant Secretary of Labor for Occupational Safety and Health or of the Director of the National Institute for Occupational Safety and Health. Employees or their authorized representatives shall have access to information on their own exposures and shall be given the opportunity to observe any measurement conducted in accordance with this section.

II. INTRODUCTION

This report presents the criteria and the recommended standard based thereon that were prepared to meet the need for preventing occupational disease or injury arising from exposure to asphalt fumes. 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 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. The criteria and the recommended standard should enable management and labor to develop better engineering controls resulting in more healthful work practices and should not be used as a final goal.

Irritation of the serous membranes of the conjunctivae and the mucous membranes of the respiratory tract are the principal adverse effects on health from exposures to asphalt fumes. Hot asphalt can cause burns of the skin. There is evidence from animal experiments that local carcinomas may result from asphalt when it is left on the skin for long periods of time. However, there have been no reports of such effects on human skin that can

be attributed to exposures to asphalt alone. Reliable reports associating malignant tumors of parenchymatous organs with exposure to asphalt fumes have not been found in the literature. Although available information has not clearly demonstrated that a direct carcinogenic hazard is associated with asphalt fumes, NIOSH is concerned that future investigations may suggest a greater occupational hazard from asphalt fumes than is currently documented in the literature. The lack of credible toxicologic evidence and the confusion in the literature regarding asphalts, tars, and pitches have precipitated this concern. The toxic effects produced by the three substances are quantitatively and qualitatively different, and in order to afford workers adequate protection, special care must be exercised in determining and defining the exposure material. In view of the unresolved issues in this particular area, NIOSH is compelled to recommend a ceiling concentration limit of 5 mg/cu m, based on total particulate, for asphalt fumes.

These criteria for a recommended standard for asphalt fumes are developed as part of a continuing series of documents published by NIOSH. The recommended standard applies to workplace exposure to asphalt fumes arising from the handling, processing, manufacture, use, or storage of asphalt. The standard was not designed for the population-at-large, and any application to situations other than occupational exposures is not warranted. It is intended to (1) protect workers exposed to asphalt fumes against irritation of the eyes, skin, and respiratory tract, (2) be measurable by techniques that are valid, reproducible, and available to industry and government agencies, and (3) be attainable with existing technology.

The major concern in occupational exposure to asphalt fumes is their potential for irritating the eyes and respiratory tract. These effects have only been reported after exposures at unknown, high concentrations, and the available literature does not permit the determination of the thresholds for adverse effects.

Retrospective and prospective epidemiologic studies are needed to assess the potential occupational hazard from asphalt fumes. These studies must consider the possible influence of individual sensitivity, predisposing factors, such as excessive alcohol use, smoking, and obesity, and previous or concurrent exposure of employees to other, more toxic materials, such as tar and pitch. Animal experiments that simulate the exposure schedules of a workplace environment should be conducted to determine maximum safe exposures. These experiments might then be useful in estimating exposure limits for humans. Further studies are also needed to investigate the carcinogenic, mutagenic, and teratogenic potentials of asphalt fumes, to improve the recommended sampling and analytical methods, and to develop, if possible, a method for biologic monitoring of significant exposure to asphalt fumes.