

OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR CARBON BLACK POTENTIAL HUMAN CARCINOGEN

INTRODUCTION

This guideline summarizes pertinent information about carbon black and carbon black containing polycyclic aromatic hydrocarbons (PAH's) for workers, employers, and occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments in these fields; therefore, readers are advised to regard these recommendations as general guidelines.

SUBSTANCE IDENTIFICATION

- **Synonyms:** Channel black, furnace black, thermal black
- **Identifiers:** CAS 1333-86-4; RTECS FF5800000; DOT Not assigned
- **Appearance and odor:** Odorless black solid

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Specific gravity (water = 1): 1.8 to 2.18
2. Vapor pressure at 20°C (68°F): Essentially zero
3. Insoluble in water

• Reactivity

1. Incompatibilities: Contact with strong oxidizers (e.g., chlorates, bromates, and nitrates) may cause fires and explosions.
2. Hazardous decomposition products: Toxic vapors and gases (e.g., carbon monoxide) may be released in a fire involving carbon black.
3. Caution: Carbon black dust may form explosive mixtures in air.

• Flammability

1. Minimum dust ignition temperature: 510°C (950°F)
2. Extinguishant: Water or carbon dioxide
3. Combustible solid, (NFPA)

• Warning properties

1. Evaluation of warning properties for respirator selection (carbon black): Based on lack of information on irritation levels, carbon black should be considered to have poor warning properties.
2. Evaluation of warning properties for respirator selection (carbon black containing PAH's): Warning properties are not

considered in recommending respirators for use with carcinogens.

EXPOSURE LIMITS

The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for carbon black is 3.5 milligrams of carbon black per cubic meter of air (mg/m³) as a time-weighted average (TWA) concentration over an 8-hour workshift. The National Institute for Occupational Safety and Health (NIOSH) recommended exposure limit (REL) for carbon black is 3.5 mg/m³ as a TWA for up to a 10-hour workshift, 40-hour workweek. NIOSH recommends that carbon black containing PAH's at a concentration greater than 0.1% be controlled and handled as a potential human carcinogen in the workplace and that exposure be minimized to the lowest feasible limit. The NIOSH REL for PAH's that may be formed during the manufacture of carbon black and that could be adsorbed on the carbon black is 0.1 mg/m³ (measured as the cyclohexane-extractable fraction) as a TWA for up to a 10-hour workshift, 40-hour workweek. The American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV[®]) is 3.5 mg/m³ as a TWA for a normal 8-hour workday and a 40-hour workweek.

Table 1.—Occupational exposure limits for carbon black

	Exposure limits mg/m ³
OSHA PEL TWA	3.5
NIOSH REL TWA (carbon black)	3.5
TWA (PAH's) (Ca)*	0.1
ACGIH TLV [®] TWA	3.5

* (Ca): NIOSH recommends treating as a potential human carcinogen when the concentration of PAH's is greater than 0.1%.

HEALTH HAZARD INFORMATION

• Routes of exposure

Carbon black may cause adverse health effects following exposure via inhalation, ingestion, or dermal contact.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health
Division of Standards Development and Technology Transfer

• Summary of toxicology

1. *Effects on animals:* Inhalation of carbon black by mice, rats, and monkeys caused thickened alveolar walls, increased pulmonary collagen, right atrial and ventricular strain, hypertrophy of the right and left ventricles and septum, and increased heart weights. Although carbon black itself did not cause cancer in treated animals, carbon black containing polynuclear hydrocarbons (PNA's) or PAH's did cause cancer following chronic administration by all routes tested.

2. *Effects on humans:* Chronic inhalation exposure of production workers has caused decreased pulmonary function and myocardial dystrophy. There is suggestive but inconclusive evidence that carbon black containing PAH's has been responsible for induction of skin cancer in exposed workers.

• Signs and symptoms of exposure

Long-term (chronic): Inhalation of carbon black can cause cough, phlegm, tiredness, chest pain, and headache. Dermal, mucosal, or inhalation exposure can cause irritation.

RECOMMENDED MEDICAL PRACTICES

• Medical surveillance program

Workers with potential exposures to chemical hazards should be monitored in a systematic program of medical surveillance intended to prevent or control occupational injury and disease. The program should include education of employers and workers about work-related hazards, placement of workers in jobs that do not jeopardize their safety and health, earliest possible detection of adverse health effects, and referral of workers for diagnostic confirmation and treatment. The occurrence of disease (a "sentinel health event," SHE) or other work-related adverse health effects should prompt immediate evaluation of primary preventive measures (e.g., industrial hygiene monitoring, engineering controls, and personal protective equipment). A medical surveillance program is intended to supplement, not replace, such measures.

A medical surveillance program should include systematic collection and epidemiologic analysis of relevant environmental and biologic monitoring, medical screening, morbidity, and mortality data. This analysis may provide information about the relatedness of adverse health effects and occupational exposure that cannot be discerned from results in individual workers. Sensitivity, specificity, and predictive values of biologic monitoring and medical screening tests should be evaluated on an industry-wide basis prior to application in any given worker group. Intrinsic to a surveillance program is the dissemination of summary data to those who need to know, including employers, occupational health professionals, potentially exposed workers, and regulatory and public health agencies.

• Preplacement medical evaluation

Prior to placing a worker in a job with a potential for exposure to carbon black, the physician should evaluate and document the worker's baseline health status with thorough medical, environmental, and occupational histories, a physical examination, and physiologic and laboratory tests appropriate for the anticipated occupational risks. These should concentrate on the function and integrity of the skin and respiratory system.

Medical surveillance for respiratory disease should be conducted by using the principles and methods recommended by NIOSH and the American Thoracic Society (ATS).

A preplacement medical evaluation is recommended in order to detect and assess preexisting or concurrent conditions which may be aggravated or result in increased risk when a worker is exposed to carbon black at or below the NIOSH REL. The examining physician should consider the probable frequency, intensity, and duration of exposure, as well as the nature and degree of the condition, in placing such a worker. Such conditions, which should not be regarded as absolute contraindications to job placement, include a history of chronic skin disease or concurrent dermatitis.

• Periodic medical screening and/or biologic monitoring

Occupational health interviews and physical examinations should be performed at regular intervals. Additional examinations may be necessary should a worker develop symptoms that may be attributed to exposure to carbon black. The interviews, examinations, and appropriate medical screening and/or biologic monitoring tests should be directed at identifying an excessive decrease or adverse trend in the physiologic function of the skin and respiratory system as compared to the baseline status of the individual worker or to expected values for a suitable reference population. The following tests should be used and interpreted according to standardized procedures and evaluation criteria recommended by NIOSH and ATS: standardized questionnaires and tests of lung function.

• Medical practices recommended at the time of job transfer or termination

The medical, environmental, and occupational history interviews, the physical examination, and selected physiologic and laboratory tests which were conducted at the time of placement should be repeated at the time of job transfer or termination. Any changes in the worker's health status should be compared to those expected for a suitable reference population. Because occupational exposure to carbon black may cause diseases of prolonged induction-latency, the need for medical surveillance may extend well beyond termination of employment.

MONITORING AND MEASUREMENT PROCEDURES

• TWA exposure evaluation

Measurements to determine worker exposure to carbon black should be taken so that the TWA exposure is based on a single entire workshift sample or an appropriate number of consecutive samples collected during the entire workshift. Under certain conditions, it may be appropriate to collect several short-term interval samples (up to 30 minutes each) to determine the average exposure level. Air samples should be taken in the worker's breathing zone (air that most nearly represents that inhaled by the worker).

• Method

Sampling and analysis may be performed by collecting carbon black particulate with tared 5 μ m PVC membrane filters and analyzing by gravimetric methods. A detailed sampling and analytical method for carbon black may be found in the *NIOSH Manual of Analytical Methods* (method number 5000). Sam-

pling and analysis of PAH's present in the particulate or the filters may be performed by extracting with cyclohexane (aided by sonification), filtering through a fritted glass funnel, and weighing a dried aliquot of the extract. A detailed sampling and analytical method for cyclohexane-extractable PAH's may be found in *Criteria for a Recommended Standard. . . Occupational Exposure to Carbon Black*.

PERSONAL PROTECTIVE EQUIPMENT

Chemical protective clothing (CPC) should be selected after utilizing available performance data, consulting with the manufacturer, and then evaluating the clothing under actual use conditions.

Workers should be provided with and required to use CPC, gloves, face shields (8-inch minimum), and other appropriate protective clothing necessary to prevent skin contact with carbon black.

Workers should be provided with and required to use dust-proof safety goggles where carbon black may come in contact with the eyes.

SANITATION

Clothing which is contaminated with carbon black should be removed immediately and placed in closed containers for storage until it can be discarded or until provision is made for the removal of carbon black from the clothing. If the clothing is to be laundered or cleaned, the person performing the operation should be informed of carbon black's hazardous properties. Reusable clothing and equipment should be checked for residual contamination before reuse or storage.

A change room with showers, washing facilities, and lockers that permit separation of street and work clothes should be provided.

Workers should be required to shower following a workshift and prior to putting on street clothes. Clean work clothes should be provided daily.

Skin that becomes contaminated with carbon black should be promptly washed with soap and water.

The storage, preparation, dispensing, or consumption of food or beverages, the storage or application of cosmetics, the storage or smoking of tobacco or other smoking materials, or the storage or use of products for chewing should be prohibited in work areas.

Workers who handle carbon black should wash their faces, hands, and forearms thoroughly with soap and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

Common operations in which exposure to carbon black may occur and control methods which may be effective in each case are listed in Table 2.

Table 2.—Operations and methods of control for carbon black

Operations	Controls
During the manufacture of natural and synthetic rubber, dry cells, explosives, plastics, and paper	Local exhaust ventilation, personal protective equipment
During the manufacture and distribution of carbon black; during maintenance of equipment and storage containers	Local exhaust ventilation, personal protective equipment
During the manufacture and use of coatings and printing inks; during use as a coloring pigment and source of carbon	Local exhaust ventilation, personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, remove the victim from further exposure, send for medical assistance, and initiate emergency procedures.

• Eye exposure

Where there is any possibility of a worker's eyes being exposed to carbon black, an eye-wash fountain should be provided within the immediate work area for emergency use.

If carbon black gets into the eyes, flush them immediately with large amounts of water for 15 minutes, lifting the lower and upper lids occasionally. Get medical attention as soon as possible. Contact lenses should not be worn when working with this chemical.

• Skin exposure

Where there is any possibility of a worker's body being exposed to carbon black containing PAH's, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.

If carbon black gets on the skin, wash it immediately with soap and water. If carbon black penetrates the clothing, remove the clothing immediately and wash the skin with soap and water. Get medical attention promptly.

• Rescue

If a worker has been incapacitated, move the affected worker from the hazardous exposure. Put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILLS AND LEAKS

Workers not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

If carbon black is spilled or leaked, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of spill or leak.
3. Carbon black dust may be collected by vacuuming with an appropriate high-efficiency filtration system or by using wet methods; it should then be placed in an appropriate container. If a vacuum system is used, there should be no sources of ignition in the vicinity of the spill, and flashback prevention devices should be provided.

WASTE REMOVAL AND DISPOSAL

U.S. Environmental Protection Agency, Department of Transportation, and/or state and local regulations shall be followed to assure that removal, transport, and disposal are in accordance with existing regulations.

RESPIRATORY PROTECTION

It must be stressed that the use of respirators is the least preferred method of controlling worker exposure and should not normally be used as the only means of preventing or minimizing exposure during routine operations. However, there are some exceptions for which respirators may be used to control exposure: when engineering and work practice controls are not technically feasible, when engineering controls are in the process of being installed, or during emergencies and certain maintenance operations including those requiring confined-space entry (Tables 3 and 4).

In addition to respirator selection, a complete respiratory protection program should be instituted which as a minimum complies with the requirements found in the OSHA Safety and Health Standards 29 CFR 1910.134. A respiratory protection program should include as a minimum an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, fit testing, periodic environmental monitoring, maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program, including selection of the correct respirators, requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly.

Only respirators that have been approved by the Mine Safety and Health Administration (MSHA, formerly Mining Enforcement and Safety Administration) and by NIOSH should be used. **Remember! Air-purifying respirators will not protect from oxygen-deficient atmospheres.**

For each level of respirator protection, only those respirators that have the minimum required protection factor and meet other use restrictions are listed in Table 3. All respirators that have higher protection factors may also be used. Table 4 lists respirators for protection against carcinogens, which includes only those respirators providing the highest protection factor available.

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Table 3.—Respiratory protection for carbon black

Condition	Minimum respiratory protection*†
Concentration:	
Less than or equal to 17.5 mg/m ³	Any dust and mist respirator
Less than or equal to 35 mg/m ³	Any dust and mist respirator except single-use and quarter-mask respirators Any supplied-air respirator Any air-purifying respirator with a high-efficiency particulate filter Any self-contained breathing apparatus
Less than or equal to 87.5 mg/m ³	Any powered air-purifying respirator with a dust and mist filter Any supplied-air respirator operated in a continuous flow mode
Less than or equal to 175 mg/m ³	Any air-purifying full facepiece respirator with a high-efficiency particulate filter Any powered air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter Any self-contained breathing apparatus with a full facepiece Any supplied-air respirator with a full facepiece
Less than or equal to 3,500 mg/m ³	Any supplied-air respirator with a half-mask and operated in a pressure-demand or other positive pressure mode
Planned or emergency entry into environments containing unknown concentrations or levels above 3,500 mg/m ³	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode
Firefighting	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode
Escape only	Any air-purifying full facepiece respirator with a high-efficiency particulate filter Any appropriate escape-type self-contained breathing apparatus

* Only NIOSH/MSHA-approved equipment should be used.

† The respiratory protection listed for any given condition is the minimum required to meet the NIOSH REL of 3.5 mg/m³ (TWA).

Table 4.—Respiratory protection for carbon black containing greater than 0.1% PAH's

Condition	Minimum respiratory protection*
Any detectable concentration	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode
Planned or emergency entry into environments containing unknown or any detectable concentration	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode
Firefighting	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode
Escape only	Any air-purifying full facepiece respirator with a high-efficiency particulate filter Any appropriate escape-type self-contained breathing apparatus

* Only NIOSH/MSHA-approved equipment should be used.