Hydrogen Bromide

Bromine (incompatibilities) acetaldehyde, alcohols, alkalis, amines, combustible materials, ethylene, fluorine, hydrogen, ketones (acetone, carbonyls, etc.), metals, sulfur

A colorless, nonflammable, liquified and corrosive gas with a penetrating odor.
Highly Toxic. Attacks mucous membranes and eyes. Can cause lung damage.
Dry Gas: Stainless steel. Moist Gas: Monel valves, platinum, tantalum, high pressure steel in presence of moisture.

TLV-TWA	Flammable Limits	DOT Class / Label
3 ppm	Nonflammable	2.3 / Poison Gas

Molecular Weight	Specific Gravity	Specific Volume
80.9	2.812 @ 77° F	4.8 cu.ft./lb @ 70° F

CGA Valve Outlet	CAS Registry No.	UN Number
330	10035-10-6	1048

A highly toxic, colorless, nonflammable liquefied gas with a sharp, pungent odor.
Toxicity: Highly toxic. Extremely irritating and destructive to tissues; contact with the skin causes severe burns.
TWA: 3 ppm ceiling (ACGIH)
Compatible Materials: Carbon steel is satisfactory under anhydrous conditions. However, in the presence of moisture, Teflon, Kel-F, or Hastelloy B materials will resist corrosion. Avoid use of copper, brass, or galvanized piping.
Molecular Weight: 80.92
Specific Volume at 70oF and 1 atm: 4.74 ft3/lb
DOT Hazard Class: Poison Gas (2.3)
DOT Label: Poison Gas and Corrosive
DOT ID No.: UN 1048

Hydrobromic acid	Hydrogen bromide
CAS 10035-10-6	CAS 10035-10-6

Formula

Reagent grade conc HBr	HBr
contains 48 wt % HBr in water	

Physical Properties

bp 126 °C, mp -11 °C	bp -67 ° C, mp -87 °C
Miscible with water	Miscible with water

Odor

Sharp, irritating odor detectable at 2 ppm	Sharp, irritating odor detectable at 2 ppm

Vapor Density
2.71 (air = 1.0)

Toxicity Data
LD oral (rabbit)
900 mg/kg

LC inhal (rat)
2858 ppm/1 h

PEL (OSHA)
3 ppm (10 mg/m)

TLV (ACGIH)
3 ppm (10 mg/m; ceiling)

Major Hazards
Highly corrosive; causes severe burns on eye and skin contact and upon inhalation of gas.

Toxicity
Hydrobromic acid and hydrogen bromide gas are highly corrosive substances that can cause severe burns upon contact with all body tissues. The aqueous acid and gas are strong eye irritants and lacrimators. Contact of concentrated hydrobromic acid or concentrated HBr vapor with the eyes may cause severe injury, resulting in permanent impairment of vision and possible blindness. Skin contact with the acid or HBr gas can produce severe burns. Ingestion can lead to severe burns of the mouth, throat, and gastrointestinal system

and can be fatal. Inhalation of hydrogen bromide gas can cause extreme irritation and injury to the upper respiratory tract and lungs, and exposure to high concentrations may cause death. HBr gas is regarded as having adequate warning properties.

Hydrogen bromide has not been found to be carcinogenic or to show reproductive or developmental toxicity in humans.

Flammability and Explosibility
Noncombustible, but contact with metals may produce highly flammable hydrogen gas.

Reactivity and Incompatibility
Hydrobromic acid and hydrogen bromide react violently with many metals with the generation of highly flammable hydrogen gas, which may explode. Reaction with oxidizers such as permanganates, chlorates, chlorites, and hypochlorites may produce chlorine or bromine.

Storage and Handling
Hydrobromic acid should be handled in the laboratory using the "basic prudent practices" described in Chapter 5.C. Splash goggles and rubber gloves should be worn when handling this acid, and containers of HBr should be stored in a well-ventilated location separated from incompatible metals. Water should never be added to HBr because splattering may result; always add acid to water. Containers of hydrobromic acid should be stored in secondary plastic trays to avoid corrosion of metal storage shelves due to drips or spills.

Hydrogen bromide gas should be handled in the laboratory using the "basic prudent practices" described in Chapter 5.C, supplemented by the procedures described in Chapter 5.H for the handling of compressed gases. Cylinders of hydrogen bromide should be stored in cool, dry locations, separated from alkali metals and other incompatible substances.

Accidents

In the event of skin contact, remove contaminated clothing and immediately wash with flowing water for at least 15 min. In case of eye contact,

immediately wash with copious amounts of water for at least 15 min while holding the eyelids open. Seek medical attention. In case of ingestion, do not induce vomiting. Give large amounts of water or milk if available and transport to medical facility. In case of inhalation, remove to fresh air and seek medical attention.

Carefully neutralize spills of hydrobromic acid with a suitable agent such as powdered sodium bicarbonate, further dilute with absorbent material, place in an appropriate container, and dispose of properly. Dilution with water before applying the solid adsorbent may be an effective means of reducing exposure to hydrogen bromide vapor. Respiratory protection may be necessary in the event of a large spill or release in a confined area.

Leaks of HBr gas are evident from the formation of dense white fumes on contact with the atmosphere. Small leaks can be detected by holding an open container of concentrated ammonium hydroxide near the site of the suspected leak; dense white fumes confirm a leak is present. In case of the accidental release of hydrogen bromide gas, such as from a leaking cylinder or associated apparatus, evacuate the area and eliminate the source of the leak if this can be done safely. Remove cylinder to a fume hood or remote area if it cannot be shut off. Full respiratory protection and protective clothing may be required to deal with a hydrogen bromide release.

Disposal

Hydrobromic acid and waste material containing this substance should be placed in an appropriate container, clearly labeled and stored in the designated HBr cabinet. Excess hydrogen bromide in cylinders should be returned to the manufacturer.

Chemicals. This LCSS presents a concise summary of safety information that should be adequate for most laboratory uses of the title substance, but in some cases it may be advisable to consult more comprehensive references. This information should not be used as a guide to the nonlaboratory use of this chemical.

OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR HYDROGEN BROMIDE

INTRODUCTION

This guideline summarizes pertinent information about hydrogen bromide for workers and employers as well as for physicians, industrial hygienists, and other 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; readers are therefore advised to regard these recommendations as general guidelines and to determine whether new information is available.

SUBSTANCE IDENTIFICATION

* Formula

HBr

* Structure

(For Structure, see paper copy)

* Synonyms

Anhydrous hydrobromic acid, anhydrous hydrogen bromide, hydrobromic acid

* Identifiers

1. CAS No.: 10035-10-6

2. RTECS No.: MW3850000

3. DOT UN: 1048 15

4. DOT label: Poison gas, corrosive

* Appearance and odor

Hydrogen bromide is a colorless, corrosive, nonflammable gas with a sharp, unpleasant, pungent odor. The air odor threshold concentration for hydrogen bromide is 2.0 parts per million (ppm) parts of air.

CHEMICAL AND PHYSICAL PROPERTIES

* Physical data

1. Molecular weight: 80.92

2. Boiling point (at 760 mm Hg): -67 degrees C (-88.6 degrees F)

3. Specific gravity: 2.77 at -67 degrees C (-88.6 degrees F)

4. Vapor density: 3.5

5. Melting point: -86.9 degrees C (-124.42 degrees F)

6. Vapor pressure at 20 degrees C (68 degrees F): Greater than 1 mm Hg

7. Solubility: Soluble in water, alcohol and organic solvents.

8. Evaporation rate: Data not available.

* Reactivity

1. Conditions contributing to instability: Exposure to moisture or water, can produce hydrogen which may form explosive mixtures with air.

2. Incompatibilities: Contact between hydrogen bromide and strong oxidizers, ammonia, strong caustics, fluorine, or common metals such as, copper, brass, and zinc, mixed with moisture may cause explosive reactions to occur. A reaction of hydrogen bromide with fluorine may be accompanied by flame. The evolution of dangerous, toxic and corrosive fumes may occur when this substance mixes with water or steam. It can also react instantaneously with ozone to cause an explosion.

3. Hazardous decomposition products: Toxic gases and vapors such as hydrogen or bromine may be released in a fire involving hydrogen bromide.

4. Special precautions: None reported.

* Flammability

Hydrogen bromide is nonflammable gas.

The National Fire Protection Association has assigned a flammability rating of 0 (minimal fire hazard) to hydrogen bromide.

1. Flash point: Not applicable.

2. Autoignition temperature: Not applicable.

3. Flammable limits in air: Not applicable.

4. Extinguishant: For small fires use dry chemical or carbon dioxide. Use water spray, fog, or regular foam to fight large fires involving hydrogen bromide.

Fires involving hydrogen bromide should be fought upwind from the maximum distance possible. Keep unnecessary people away; isolate the hazard area and deny entry. Isolate the leak or spill area for at least 150 feet in all directions, until gas has dispersed. Emergency personnel should stay out of low areas and ventilate closed spaces before entering. Containers of hydrogen bromide may explode in the heat of the fire and should be moved from the fire area if it is possible to do so safely. If this is not possible, cool fire exposed containers from the sides with water until well after the fire is out. Do not get water inside the containers. Stay away from the ends of containers. Firefighters should wear a full set of chemical protective clothing and self-contained breathing apparatus when fighting fires involving hydrogen bromide.

EXPOSURE LIMITS

* OSHA PEL

The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for hydrogen bromide is 3 ppm (10 milligrams per cubic meter (mg/m(3)) as an 8-hour time-weighted average (TWA) concentration [29 CFR 1910.1000, Table Z-1].

* NIOSH REL

The National Institute for Occupational Safety and Health (NIOSH) has established a recommended exposure limit (REL) for hydrogen bromide of 3 ppm (10 mg/m(3)) as a ceiling which should not be exceeded during any part of the working exposure [NIOSH 1992].

* ACGIH TLV

The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned hydrogen bromide a ceiling of 3 ppm (9.9 mg/m(3)), which should not be exceeded during any part of the working exposure [ACGIH 1994, p. 23].

* Rationale for Limits

The NIOSH limit is based on the risk of eye, mucous membrane, and skin irritation [NIOSH 1992].

The ACGIH limit is based on the risk of irritation [ACGIH 1991, p. 771].

HEALTH HAZARD INFORMATION

* Routes of Exposure

Exposure to hydrogen bromide can occur through inhalation, ingestion, and eye or skin contact [Sittig 1991].

* Summary of toxicology

1. Effects on Animals: Hydrogen bromide is a corrosive irritant to the eyes, skin, and mucous membrane. The 1-hour LC(50)s in rats and mice are 2,850 and 814 ppm, respectively [Hathaway et al. 1991].

2. Effects on Humans: Hydrogen bromide is a strong primary irritant of the eyes, skin, and mucous membranes of the upper respiratory tract. In an experimental setting, several minutes of exposure to hydrogen bromide at a concentration of 5 ppm caused nose irritation in all six subjects and throat irritation in one of the six [ACGIH 1991]. Long-term exposure may cause chronic nasal and bronchial discharge and chronic indigestion [Sittig 1991]. Skin, eye, or mucous membrane contact with hydrogen bromide solutions may result in severe burns and necrosis [Sittig 1991; NLM 1992]. Ingestion of the liquid can produce burns to the mouth and stomach [NLM 1992]. At high concentrations, inhalation may result in lung injury or death. Exposure to concentrations of between 1,300 and 2,000 ppm has resulted in death [NLM 1992].

* Signs and symptoms of exposure

1. Acute exposure: Acute exposure to hydrogen bromide may cause extreme irritation of the eyes, skin, and mucous membranes of the upper respiratory tract. Contact of hydrogen bromide solutions with the eyes, skin, or mucous membranes may cause burns. Death may result from edema or spasm of the larynx and inflammation of the upper respiratory tract.

2. Chronic exposure: Chronic exposure to hydrogen bromide may cause nasal and bronchial discharge and indigestion.

EMERGENCY MEDICAL PROCEDURES

* Emergency medical procedures: [NIOSH to supply]

5. Rescue: Remove an incapacitated worker from further exposure and implement appropriate emergency procedures (e.g., those listed on the Material Safety Data Sheet required by OSHA's Hazard Communication Standard [29 CFR 1910.1200]). All workers should be familiar with emergency procedures, the location and proper use of emergency equipment, and methods of protecting themselves during rescue operations.

EXPOSURE SOURCES AND CONTROL METHODS

The following operations may involve hydrogen bromide and lead to worker exposures to this substance:

* The manufacture and transportation of hydrogen bromide

* Use in manufacture of inorganic bromides for use in photography, pharmaceuticals, industrial drying, textile finishing, engraving and lithography, chemical synthesis, and fire retardants

* Use in manufacture of brominated fluorocarbons for fire extinguishing, refrigeration, and aerosols

* Use in organic synthesis as an intermediate (e.g., for barbiturate manufacture and the manufacture of synthetic hormones); as a catalyst for alkylation of aromatic compounds (e.g., in

the petroleum industry); controlled oxidations, isomerization of conjugated diolefins, and polymerization

* Use as a reagent in analytical chemistry; in the etching of germanium crystals, silicon disks, and metal alloys

* Use as a solvent for ore minerals

Methods that are effective in controlling worker exposures to hydrogen bromide, depending on the feasibility of implementation, are as follows:

* Process enclosure

* Local exhaust ventilation

* General dilution ventilation

* Personal protective equipment

Workers responding to a release or potential release of a hazardous substance must be protected as required by paragraph (q) of OSHA's Hazardous Waste Operations and Emergency Response Standard [29 CFR 1910.120].

Good sources of information about control methods are as follows:

1. ACGIH [1992]. Industrial ventilation--a manual of recommended practice. 21st ed. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

2. Burton DJ [1986]. Industrial ventilation--a self study companion. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

3. Alden JL, Kane JM [1982]. Design of industrial ventilation systems. New York, NY: Industrial Press, Inc.

4. Wadden RA, Scheff PA [1987]. Engineering design for control of workplace hazards. New York, NY: McGraw-Hill.

5. Plog BA [1988]. Fundamentals of industrial hygiene. Chicago, IL: National Safety Council.

MEDICAL SURVEILLANCE

OSHA is currently developing requirements for medical surveillance. When these requirements are promulgated, readers should refer to them for additional information and to determine whether employers whose employees are exposed to hydrogen bromide are required to implement medical surveillance procedures.

* Medical Screening

Workers who may be exposed to chemical hazards should be monitored in a systematic program of medical surveillance that is intended to prevent occupational injury and disease. The program should include education of employers and workers about work-related hazards, early detection of adverse health effects, and referral of workers for diagnosis and treatment. The occurrence of

disease 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. To detect and control work-related health effects, medical evaluations should be performed (1) before job placement, (2) periodically during the term of employment, and (3) at the time of job transfer or termination.

* Preplacement medical evaluation

Before a worker is placed in a job with a potential for exposure to hydrogen bromide, a licensed health care professional 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 respiratory system and nervous system. Medical surveillance for respiratory disease should be conducted using the principles and methods recommended by the American Thoracic Society.

A preplacement medical evaluation is recommended to assess medical conditions that may be aggravated or may result in increased risk when a worker is exposed to hydrogen bromide at or below the prescribed exposure limit. The health care professional should consider the probable frequency, intensity, and duration of exposure as well as the nature and degree of any applicable medical condition. Such conditions (which should not be regarded as absolute contraindications to job placement) include a history and other findings consistent with diseases of the respiratory system and nervous system.

* Periodic medical evaluations

Occupational health interviews and physical examinations should be performed at regular intervals during the employment period, as mandated by any applicable Federal, State, or local standard. Where no standard exists and the hazard is minimal, evaluations should be conducted every 3 to 5 years or as frequently as recommended by an experienced occupational health physician. Additional examinations may be necessary if a worker develops symptoms attributable to hydrogen bromide exposure. The interviews, examinations, and medical screening tests should focus on identifying the adverse effects of hydrogen bromide on the respiratory system or nervous system. Current health status should be compared with the baseline health status of the individual worker or with expected values for a suitable reference population.

* Termination medical evaluations

The medical, environmental, and occupational history interviews, the physical examination, and selected physiologic or laboratory tests that were conducted at the time of placement should be repeated at the time of job transfer or termination to determine the worker's medical status at the end of his or her employment. Any changes in the worker's health status should be compared with those expected for a suitable reference population.

* Biological monitoring

Biological monitoring involves sampling and analyzing body tissues or fluids to provide an index of exposure to a toxic substance or metabolite. No biological monitoring test acceptable for routine use has yet been developed for hydrogen bromide.

WORKPLACE MONITORING AND MEASUREMENT

Determination of a worker's exposure to airborne hydrogen bromide is made using a treated silica gel tube. Samples are collected at a maximum flow rate of 0.2 liter/minute TWA, or 0.5 liter/minute ceiling until a maximum collection volume of 90 liters (TWA) or 2.5 liters (ceiling) is reached. Analysis is conducted by ion chromatography. This method (OSHA 165G) is partially validated and is described in the OSHA Computerized Information System [OSHA 1994] and in NIOSH Method No. 7903 (inorganic acids) [NIOSH 1994].

PERSONAL HYGIENE PROCEDURES

If hydrogen bromide contacts the skin, workers should flush the affected areas immediately with plenty of water.

Clothing contaminated with hydrogen bromide should be removed immediately, and provisions should be made for the safe removal of the chemical from the clothing. Persons laundering the clothes should be informed of the hazardous properties of hydrogen bromide, particularly its potential for causing irritation and burns.

A worker who handles hydrogen bromide should thoroughly wash hands, forearms, and face with soap and water before eating, using tobacco products, using toilet facilities, applying cosmetics, or taking medication.

Workers should not eat, drink, use tobacco products, apply cosmetics, or take medication in areas where hydrogen bromide or a solution containing hydrogen bromide is handled, processed, or stored.

STORAGE

Hydrogen bromide should be stored in a cool, dry, well-ventilated area in tightly sealed containers that are labeled in accordance with OSHA's Hazard Communication Standard [29 CFR 1910.1200]. Store in pressurized steel containers. Containers of hydrogen bromide should be protected from physical damage and should be stored separately from strong oxidizers, ammonia, strong caustics, fluorine, common metals such as copper, brass, and zinc, moisture, fluorine, or ozone.

SPILLS AND LEAKS

In the event of a spill or leak involving hydrogen bromide, persons not wearing protective equipment and clothing should be restricted from contaminated areas until cleanup has been completed. The following steps should be undertaken following a spill or leak:

Notify safety personnel.

1. Remove all sources of heat and ignition.

2. Ventilate the area of the spill or leak.

3. Stop the leak if it is possible to do so without risk. Use a water spray to protect personnel attempting to stop the leak. Prevent hazardous formation of hydrogen formide gas.

4. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty.

5. Spills of hydrobromic acid may be carefully neutralized by adding weak bases such as sodium bicarbonate, soda ash, or slaked lime to the spill.

SPECIAL REQUIREMENTS

U.S. Environmental Protection Agency (EPA) requirements for emergency planning, reportable quantities of hazardous releases, community right-to-know, and hazardous waste management may change over time. Users are therefore advised to determine periodically whether new information is available.

* Emergency planning requirements

Hydrogen bromide is not subject to EPA emergency planning requirements under the Superfund Amendments and Reauthorization Act (SARA) (Title III) in 42 USC 11022.

* Reportable quantity requirements for hazardous releases

A hazardous substance release is defined by EPA as any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment (including the abandonment or discarding of contaminated containers) of hazardous substances. In the event of a release that is above the reportable quantity for that chemical, employers are required to notify the proper Federal, State, and local authorities [40 CFR 355.40].

Employers are not required by the emergency release notification provisions in 40 CFR Part 355.40 to notify the National Response Center of an accidental release of hydrogen bromide; there is no reportable quantity for this substance.

* Community right-to-know requirements

Employers are not required by EPA in 40 CFR Part 372.30 to submit a Toxic Chemical Release Inventory form (Form R) to EPA reporting the amount of hydrogen bromide emitted or released from their facility annually.

* Hazardous waste management requirements

EPA considers a waste to be hazardous if it exhibits any of the following characteristics: ignitability, corrosivity, reactivity, or toxicity as defined in 40 CFR 261.21-261.24. Under the Resource Conservation and Recovery Act (RCRA) [40 USC 6901 et seq.], EPA has specifically listed many chemical wastes as hazardous. Although hydrogen bromide is not specifically listed as a hazardous waste under RCRA, EPA requires employers to treat waste as hazardous if it exhibits any of the characteristics discussed above.

Providing detailed information about the removal and disposal of specific chemicals is beyond the scope of this guideline. The U.S. Department of Transportation, EPA, and State and local regulations should be followed to ensure that removal, transport, and disposal of this substance are conducted in accordance with existing regulations. To be certain that chemical waste disposal meets EPA regulatory requirements, employers should address any questions to the RCRA hotline at (703) 412-9810 (in the Washington, D.C. area) or toll-free at (800) 424-9346 (outside Washington, D.C.). In addition, relevant State and local authorities should be contacted for information on any requirements they may have for the waste removal and disposal of this substance.

RESPIRATORY PROTECTION

* Conditions for respirator use

Good industrial hygiene practice requires that engineering controls be used where feasible to reduce workplace concentrations of hazardous materials to the prescribed exposure limit. However, some situations may require the use of respirators to control exposure. Respirators must be worn if the ambient concentration of hydrogen bromide exceeds prescribed exposure limits. Respirators may be used (1) before engineering controls have been installed, (2) during work operations such as maintenance or repairactivities that involve unknown exposures, (3) during operations that require entry into tanks or closed vessels, and (4) during emergencies. Workers should only use respirators that have been approved by NIOSH and the Mine Safety and Health Administration (MSHA).

* Respiratory protection program

Employers should institute a complete respiratory protection program that, at a minimum, complies with the requirements of OSHA's Respiratory Protection Standard [29 CFR 1910.134]. Such a program must include respirator selection, an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, respirator fit testing, periodic workplace monitoring, and regular respirator maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program (including selection of the correct respirator) requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly. For additional information on the selection and use of respirators and on the medical screening of respirator users, consult the latest edition of the NIOSH Respirator Decision Logic [NIOSH 1987b] and the NIOSH Guide to Industrial Respiratory Protection [NIOSH 1987a].

PERSONAL PROTECTIVE EQUIPMENT

Workers should use appropriate personal protective clothing and equipment that must be carefully selected, used, and maintained to be effective in preventing skin contact with hydrogen bromide. The selection of the appropriate personal protective equipment (PPE) (e.g., gloves, sleeves, encapsulating suits) should be based on the extent of the worker's potential exposure to hydrogen bromide. The resistance of one PPE material to permeation by hydrogen bromide (30 to 70 percent) is shown below:

Material	**Breakthrough time (hr)**
Responder	>8

To evaluate the use of this or other PPE materials with hydrogen bromide, users should consult the best available performance data and manufacturers' recommendations. Significant differences have been demonstrated in the chemical resistance of generically similar PPE materials (e.g., butyl) produced by different manufacturers. In addition, the chemical resistance of a mixture may be significantly different from that of any of its neat components.

Any chemical-resistant clothing that is used should be periodically evaluated to determine its effectiveness in preventing dermal contact. Safety showers and eye wash stations should be located close to operations that involve hydrogen bromide.

Splash-proof chemical safety goggles or face shields (20 to 30 cm long, minimum) should be worn during any operation in which a solvent, caustic, or other toxic substance may be splashed into the eyes.

In addition to the possible need for wearing protective outer apparel (e.g., aprons, encapsulating suits), workers should wear work uniforms, coveralls, or similar full-body coverings that are laundered each day. Employers should provide lockers or other closed areas to store work and street clothing separately. Employers should collect work clothing at the end of each work shift and provide for its laundering. Laundry personnel should be informed about the potential hazards of handling contaminated clothing and instructed about measures to minimize their health risk.

Protective clothing should be kept free of oil and grease and should be inspected and maintained regularly to preserve its effectiveness.

Protective clothing may interfere with the body's heat dissipation, especially during hot weather or during work in hot or poorly ventilated work environments.

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