

Occupational Health Guideline for Hydrogen Bromide

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formula: HBr
- Synonyms: Anhydrous hydrobromic acid
- Appearance and odor: Colorless gas with an irritating, sharp odor. It also can be a liquid when stored under pressure.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for hydrogen bromide is 3 parts of hydrogen bromide per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 10 milligrams of hydrogen bromide per cubic meter of air (mg/m³).

HEALTH HAZARD INFORMATION

- Routes of exposure
Hydrogen bromide can affect the body if it is inhaled or if it comes in contact with the eyes or skin. It can also affect the body if it is swallowed.
- Effects of overexposure
 1. *Short-term Exposure:* Hydrogen bromide may cause irritation of the eyes, nose, and throat. If a solution is splashed on the skin or in the eyes, it will cause a burn.
 2. *Long-term Exposure:* Repeated or prolonged exposure to hydrogen bromide may cause irritation of the nose and throat with mucous production and indigestion.
 3. *Reporting Signs and Symptoms:* A physician should be contacted if anyone develops any signs or symptoms

and suspects that they are caused by exposure to hydrogen bromide.

- Recommended medical surveillance

The following medical procedures should be made available to each employee who is exposed to hydrogen bromide at potentially hazardous levels:

1. *Initial Medical Screening:* Employees should be screened for history of certain medical conditions (listed below) which might place the employee at increased risk from hydrogen bromide exposure.

—Chronic respiratory disease: In persons with impaired pulmonary function, especially those with obstructive airway diseases, the breathing of hydrogen bromide might cause exacerbation of symptoms due to its irritant properties.

—Skin disease: Hydrogen bromide is a primary skin irritant. Persons with pre-existing skin disorders may be more susceptible to the effects of this agent.

—Eye disease: Hydrogen bromide is a severe eye irritant and may cause tissue damage. Those with pre-existing eye problems may be at increased risk from exposure.

2. *Periodic Medical Examination:* Any employee developing the above-listed conditions should be referred for further medical examination.

- Summary of toxicology

Hydrogen bromide gas irritates the eyes, mucous membranes, and skin. Experimental exposure of humans to 5 ppm for several minutes caused nose and throat irritation in most individuals, and a few were affected at concentrations of 3 to 4 ppm. Solutions and the vapor irritate the upper respiratory tract. Contact with the eyes, skin, or mucous membranes may cause burns.

CHEMICAL AND PHYSICAL PROPERTIES

- Physical data
 1. Molecular weight: 80.92
 2. Boiling point (760 mm Hg): -66.8 C (-88.2 F)
 3. Specific gravity (water = 1): 2.16
 4. Vapor density (air = 1 at boiling point of hydro-

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

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Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health

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gen bromide): 2.8

5. Melting point: $-86.9\text{ C} (-124\text{ F})$
6. Vapor pressure at $16.8\text{ C} (62\text{ F})$: 20 atm.
7. Solubility in water, g/100 g water at $20\text{ C} (68\text{ F})$:

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8. Evaporation rate (butyl acetate = 1): Not pertinent

• **Reactivity**

1. Conditions contributing to instability: Heat
2. Incompatibilities: Contact of liquid hydrogen bromide with strong oxidizers, strong caustics, metals, and moisture may cause violent spattering and fire.
3. Hazardous decomposition products: None
4. Special precautions: In the presence of moisture, hydrogen bromide liquid or gas will attack most metals with the formation of flammable hydrogen gas.

• **Flammability**

1. Not combustible

• **Warning properties**

1. Odor Threshold: According to the *Documentation of TLV's*, the odor of hydrogen bromide is detectable at 2 ppm.

2. Eye Irritation Level: According to the *Documentation of TLV's*, no eye irritation was observed in human subjects exposed to concentrations up to 6 ppm. Kirk and Othmer state that hydrogen bromide is an eye irritant, but do not specify the necessary concentration.

3. Other Information: The *Documentation of TLV's* reports that 1 out of 6 human subjects experienced nose and throat irritation at 3 ppm hydrogen bromide. At 4 ppm, 3 out of 6 experienced nose irritation. All exposed subjects experienced nose irritation at 5 and 6 ppm. Only 1 out of 6 subjects experienced throat irritation at concentrations of 4 ppm, 5 ppm, and 6 ppm.

4. Evaluation of Warning Properties: Through its odor and irritant effects, hydrogen bromide can be detected at the permissible exposure limit or slightly above it. Therefore, hydrogen bromide is treated as a material with adequate warning properties.

MONITORING AND MEASUREMENT PROCEDURES

• **General**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

• **Method**

Sampling and analyses may be performed by collection of hydrogen bromide in a bubbler containing sodium hydroxide, followed by analysis with an ion-specific electrode. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure hydrogen bromide may be used.

An analytical method for hydrogen bromide is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 3, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00261-4).

RESPIRATORS

• Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

• In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

• Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent any possibility of skin contact with liquid hydrogen bromide or solutions containing hydrogen bromide.

• Clothing contaminated with hydrogen bromide should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of hydrogen bromide from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the hydrogen bromide, the person performing the operation should be informed of hydrogen bromide's hazardous properties.

• Where there is any possibility of exposure of an employee's body to liquid hydrogen bromide or solutions containing hydrogen bromide, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.

• Non-impervious clothing which becomes contaminated with hydrogen bromide should be removed immediately and not reworn until the hydrogen bromide is removed from the clothing.

• Employees should be provided with and required to use splash-proof safety goggles where there is any possibility of liquid hydrogen bromide or solutions containing hydrogen bromide contacting the eyes.

- Where there is any possibility that employees' eyes may be exposed to liquid hydrogen bromide or solutions containing hydrogen bromide, an eye-wash fountain should be provided within the immediate work area for emergency use.

SANITATION

- Skin that becomes contaminated with hydrogen bromide should be immediately washed or showered to remove any hydrogen bromide.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to hydrogen bromide may occur and control methods which may be effective in each case:

Operation	Controls
Use in manufacture of inorganic bromides for use in photography, pharmaceuticals, industrial drying, textile finishing, engraving and lithography, chemical synthesis, and fire retardants	General dilution ventilation; local exhaust ventilation; personal protective equipment
Use in manufacture of brominated fluorocarbons for fire extinguishing, refrigeration, and aerosols	General dilution ventilation; local exhaust ventilation; personal protective equipment
Use in organic synthesis as intermediates for barbituate manufacture, manufacture of synthetic hormones, catalyst for alkylations, controlled oxidations, isomerizations, and polymerizations	General dilution ventilation; local exhaust ventilation; personal protective equipment
Liberation during decomposition of brominated fluorocarbon fire-extinguishing agents or flame-retardant chemicals	General dilution ventilation; local exhaust ventilation; personal protective equipment
Use as a reagent in analytical chemistry; use in etching of germanium crystals, silicon discs, and metal alloys	General dilution ventilation; local exhaust ventilation; personal protective equipment

Operation

Use as a solvent for ore minerals

Controls

General dilution ventilation; local exhaust ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• Eye Exposure

If liquid hydrogen bromide or solutions containing hydrogen bromide get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

• Skin Exposure

If liquid hydrogen bromide or solutions containing hydrogen bromide get on the skin, immediately flush the contaminated skin with water. If liquid hydrogen bromide or solutions containing hydrogen bromide penetrate through the clothing, remove the clothing immediately and flush the skin with water. Get medical attention promptly.

• Breathing

If a person breathes in large amounts of hydrogen bromide, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• Swallowing

If a solution of hydrogen bromide has been swallowed and the person is conscious, give him large quantities of water immediately to dilute the hydrogen bromide. Do not attempt to make the exposed person vomit. Get medical attention immediately.

• Rescue

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and 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.

SPILL AND LEAK PROCEDURES

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

- If hydrogen bromide is leaked, the following steps should be taken:

1. Ventilate area of leak to disperse gas.
2. If in the gaseous form, stop flow of gas. 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 the leak or allow the cylinder to empty.

3. If in the liquid form, allow to vaporize and disperse the gas.

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RESPIRATORY PROTECTION FOR HYDROGEN BROMIDE

Condition	Minimum Respiratory Protection* Required Above 3 ppm
Gas or Vapor Concentration	
50 ppm or less	Any chemical cartridge respirator with a full facepiece and an acid gas cartridge(s). A gas mask with a chin-style or a front- or back-mounted acid gas canister. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
Greater than 50 ppm or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	Any gas mask providing protection against acid gases. Any escape self-contained breathing apparatus.

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