

Occupational Health Guideline for Stibine

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: SbH_3
- Synonyms: Hydrogen antimonide; antimony trihydride
- Appearance and odor: Colorless gas with a disagreeable odor like hydrogen sulfide.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for stibine is 0.1 part of stibine per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 0.5 milligram of stibine per cubic meter of air (mg/m^3).

HEALTH HAZARD INFORMATION

• Routes of exposure

Stibine can affect the body if it is inhaled.

• Effects of overexposure

1. Short-term Exposure: Stibine may cause destruction of the red blood cells with headache, nausea, weakness, and back and abdominal pain. It may later cause dark red urine, yellow jaundice, kidney damage, and death. It may also cause lung irritation.

2. Long-term Exposure: Not known.

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 stibine.

• Recommended medical surveillance

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

1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the blood, liver, and kidneys should be stressed.

—A complete blood count: Stibine causes red blood cell hemolysis. A complete blood count should be performed including a red cell count, a white cell count, a differential count of a stained smear, as well as hemoglobin and hematocrit.

—Urinalysis: Since kidney damage has been observed in humans exposed to stibine, a urinalysis should be performed, including at a minimum specific gravity, albumin, glucose, and a microscopic on centrifuged sediment.

—Liver function tests: Since liver damage has been observed in humans exposed to stibine, a profile of liver function should be performed by using a medically acceptable array of biochemical tests.

2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis.

• Summary of toxicology

Stibine gas is an extremely toxic hemolytic agent which causes injury to the liver and kidneys; it also may be a lung irritant. Guinea pigs exposed to 65 ppm for 1 hour developed hemoglobinuria, followed within a few days by profound anemia. Cats and dogs exposed to 40-45 ppm for 1 hour developed pulmonary edema, and some died within 24 hours. Acute exposures to humans would be expected to cause rapid destruction of red blood cells, hemoglobinuria, anuria, jaundice, and death. Workers exposed to a mixture of gases of stibine, arsine, and hydrogen sulfide developed headache, weakness, nausea, abdominal and lumbar pain, hematuria, and profound anemia.

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.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 124.8
2. Boiling point (760 mm Hg): -17 C (1 F)
3. Specific gravity (water = 1): Liquid = 2.2 at boiling point
4. Vapor density (air = 1 at boiling point of stibine): 4.34
5. Melting point: -88 C (-126 F)
6. Vapor pressure at 20 C (68 F): Greater than 1 atmosphere
7. Solubility in water, g/100 g water at 20 C (68 F): 0.1
8. Evaporation rate (butyl acetate = 1): Not applicable

• Reactivity

1. Conditions contributing to instability: None
2. Incompatibilities: Stibine reacts with acids, halogenated hydrocarbons, oxidizers, and moisture.
3. Hazardous decomposition products: Antimony and hydrogen will be released when stibine decomposes.
4. Special precautions: None

• Flammability

1. Flash point: Not applicable (gas)
2. Autoignition temperature: Data not available
3. Flammable limits in air, % by volume: Data not available
4. Extinguishant: Stop flow of gas.

• Warning properties

1. Odor Threshold: Patty states that "stibine has an extremely unpleasant odor that can serve as a warning; whether the threshold of odor detection is sufficiently low to prevent injury is uncertain." No quantitative information is available concerning the odor threshold of stibine.

2. Eye Irritation Level: Stibine is not known to be an eye irritant.

3. Evaluation of Warning Properties: Since there is no quantitative information relating warning properties to air concentrations of stibine, this gas is treated as a material with poor 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 stibine on mercuric chloride-impregnated silica gel, followed by extraction with concentrated hydrochloric

acid, and colorimetric analysis. An analytical method for stibine is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 4, 1978, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00317-3).

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.

COMMON OPERATIONS AND CONTROLS

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

Operation	Controls
Liberation from treatment of scum formed on surface of molten metals treated with acid	Process enclosure; local exhaust ventilation; general dilution ventilation
Liberation during charging as storage batteries	Local exhaust ventilation; general dilution ventilation
Liberation from alloys of antimony compounds which come in contact with reducing acids	Process enclosure; local exhaust ventilation; general dilution ventilation
Liberation from purification of antimony by electrolysis	Process enclosure; local exhaust ventilation; general dilution ventilation
Use as a chemical intermediate and in chemical synthesis	Process enclosure; local exhaust ventilation; general dilution ventilation

EMERGENCY FIRST AID PROCEDURES

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

• Breathing

If a person breathes in large amounts of stibine, 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.

• 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.

LEAK PROCEDURES

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

• If stibine is leaked or released, the following steps should be taken:

1. Ventilate area of leak to disperse gas.

2. Control source of stibine formation.

REFERENCES

- American Conference of Governmental Industrial Hygienists: "Stibine," *Documentation of the Threshold Limit Values for Substances in Workroom Air* (3rd ed., 2nd printing), Cincinnati, 1974.
- American Industrial Hygiene Association: "Stibine," *Hygienic Guide Series*, Detroit, Michigan, 1960.
- Browning, E.: *Toxicity of Industrial Metals* (2nd ed.), Butterworths, London, 1969.
- Patty, F. A. (ed.): *Toxicology*, Vol. II of *Industrial Hygiene and Toxicology* (2nd ed. rev.), Interscience, New York, 1963.

RESPIRATORY PROTECTION FOR STIBINE

Condition	Minimum Respiratory Protection* Required Above 0.1 ppm
Gas Concentration	
1 ppm or less	Any supplied-air respirator. Any self-contained breathing apparatus.
5 ppm or less	Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
40 ppm or less	A Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous-flow mode.
Greater than 40 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 stibine. Any escape self-contained breathing apparatus.

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