



Arsine and Stibine

Incident Management

Key Points

Fire

- extremely flammable
- arsine and stibine react with strong oxidants; stibine reacts with chlorine, nitric acid and ozone
- arsine decomposes on heating, in light and with moisture producing toxic fumes; stibine decomposes to produce metallic antimony and hydrogen gas
- in the event of a fire involving arsine or stibine, use fine water spray and liquid and gas tight chemical protective clothing with breathing apparatus

Health

- the health effects of arsine and stibine are similar; both are toxic by inhalation
- high levels may cause severe haemolysis, renal failure and can kill rapidly
- the onset of symptoms is often delayed for several hours
- inhalation of arsine or stibine may cause headache, malaise, thirst, dizziness and breathlessness followed by abdominal pain, nausea, vomiting and diarrhoea leading to hypovolaemic shock
- fever, anaemia, jaundice, enlargement of the liver, hyperkalaemia, prolongation of the prothrombin time and pulmonary oedema may develop



Environment

- hazardous to the environment; inform the Environment Agency of substantial incidents where appropriate



Hazard Identification

Standard (UK) dangerous goods emergency action codes

Arsine







| | | | | |
|---|------------------|--------------------|---|---|
| UN | | 2188 | Arsine | |
| EAC | | 2PE ⁽¹⁾ | Use fine water spray. Wear chemical protective clothing with liquid-tight connections for whole body in combination with breathing apparatus*. Danger that the substance can be violently or explosively reactive. Spillages and decontamination run-off may be washed to drains with large quantities of water. Due care must, however, still be exercised to avoid unnecessary pollution to watercourses. There may be a public safety hazard outside the immediate area of the incident [†] | |
| APP | | A(cf) | Gas-tight chemical protective suit with breathing apparatus [‡] . Fire kit intended to protect against liquid flammable gas with a boiling point below -20°C | |
| Hazards | Class | 2.3 | Toxic gases |  |
| | Sub-risks | 2.1 | Flammable gases |  |
| HIN | | - | - | |
| <p>UN – United Nations number, EAC – emergency action code, APP – additional personal protection, HIN – hazard identification number</p> <p>* Chemical protective clothing with liquid-tight connections for whole body (type 3) conforming to the relevant standards such as BS 8428 or EN 14605, in combination with breathing apparatus BS EN 137</p> <p>† People should stay indoors with windows and doors closed, ignition sources should be eliminated and ventilation stopped. Non-essential personnel should move at least 250 m away from the incident</p> <p>‡ Normal fire kit in combination with gas-tight chemical protective clothing conforming to BS EN 943 part 2</p> <p>(1) Not applicable to the carriage of dangerous goods under the Regulations Concerning the International Carriage of Dangerous Goods by Rail (RID) or the European Agreement Concerning the International carriage Dangerous Goods by Road (ADR)</p> <p>Reference Dangerous Goods Emergency Action Code List, National Chemical Emergency Centre (NCEC) Part of Ricardo-AEA. The Stationery Office, 2017.</p> | | | | |

Stibine

| | | | | |
|--|------------------|--------------------|---|--|
| UN | | 2676 | Stibine | |
| EAC | | 2PE ⁽¹⁾ | Use fine water spray. Wear chemical protective clothing with liquid-tight connections for whole body in combination with breathing apparatus*. Danger that the substance can be violently or explosively reactive. Spillages and decontamination run-off may be washed to drains with large quantities of water. Due care must, however, still be exercised to avoid unnecessary pollution to watercourses. There may be a public safety hazard outside the immediate area of the incident [†] | |
| APP | | A(fg) | Gas-tight chemical protective suit with breathing apparatus [‡] . Fire kit intended to protect against flammable gas | |
| Hazards | Class | 2.3 | Toxic gases |  |
| | Sub-risks | 2.1 | Flammable gases |  |
| HIN | | - | - | |
| <p>UN – United Nations number, EAC – emergency action code, APP – additional personal protection, HIN – hazard identification number</p> <p>* Chemical protective clothing with liquid-tight connections for whole body (type 3) conforming to the relevant standards such as BS 8428 or EN 14605, in combination with breathing apparatus BS EN 137</p> <p>[†] People should stay indoors with windows and doors closed, ignition sources should be eliminated and ventilation stopped. Non-essential personnel should move at least 250 m away from the incident</p> <p>[‡] Normal fire kit in combination with gas-tight chemical protective clothing conforming to BS EN 943 part 2</p> <p>Reference Dangerous Goods Emergency Action Code List, National Chemical Emergency Centre (NCEC) Part of Ricardo-AEA. The Stationery Office, 2017.</p> | | | | |

Classification, labelling and packaging (CLP)*

Arsine

| | | | |
|----------------------------------|-------------------------|---|---|
| Hazard class and category | Press. Gas | Gasses under pressure |  |
| | Flam. Gas 1 | Flammable gas, category 1 |  |
| | Acute Tox. 2 | Acute toxicity (inhalation), category 2 |  |
| | STOT RE 2 | Specific target organ toxicity (repeated exposure), category 2 |  |
| | Aquatic Acute 1 | Hazardous to the aquatic environment – chronic hazard, category 1 |  |
| | Aquatic Chronic 1 | Hazardous to the aquatic environment – chronic hazard, category 1 |  |
| | Hazard statement | H220 | Extremely flammable gas |
| H330 | | Fatal if inhaled | |
| H373 | | May cause damage to organs through prolonged or repeated exposure | |
| H400 | | Very toxic to aquatic life | |
| H410 | | Very toxic to aquatic life with long lasting effects | |
| Signal words | Danger | | |

* Implemented in the EU on 20 January 2009

Reference

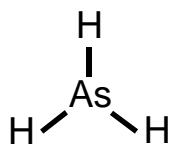
European Commission. Harmonised classification – Annexe VI to Regulation (EC) No. 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures. <http://echa.europa.eu/information-on-chemicals/cl-inventory-database> (accessed 05/2018).

Stibine

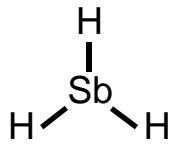
| | |
|--|------------------------------|
| Hazard class and category | No harmonised classification |
| Hazard statement | |
| Signal words | |
| Reference | |
| European Commission. Harmonised classification – Annexe VI to Regulation (EC) No. 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures. http://echa.europa.eu/information-on-chemicals/cl-inventory-database (accessed 05/2018). | |

Physicochemical Properties

Arsine

| | |
|---|---|
| CAS number | 7784-42-1 |
| Molecular weight | 78 |
| Formula | AsH ₃ |
| Common synonyms | Arsenic hydride, Arsenic trihydride, Hydrogen arsenide |
| State at room temperature | Gas |
| Volatility | Vapour pressure 11,000 mm Hg at 20°C |
| Vapour density | 2.66 (air=1) |
| Flammability | Extremely flammable |
| Lower explosive limit | 4.5% |
| Upper explosive limit | 78.0% |
| Water solubility | Low solubility in water, 280 mg/L at 20°C. |
| Reactivity | Reactive. Arsine reacts with strong oxidants, causing risk of explosion. May explosively decompose upon shock, friction or concussion |
| Reaction or degradation products | Decomposes on heating and in the presence of light and moisture, producing toxic fumes of arsenic |
| Odour | Garlic |
| Structure |  |
| References | <p>Arsine (IBM HAZARDTEXT ®) In: IBM Micromedex® TOMES® System (electronic version). Truven Health Analytics, Greenwood Village, Colorado, USA. Available at: http://www.micromedexsolutions.com/ (accessed 05/2018).</p> <p>Hazardous Substances Data Bank. Arsine HSDB No. 510 (last revision date 09/04/2013). US National Library of Medicine: Bethesda MD. http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB (accessed 05/2018).</p> <p>International Programme on Chemical Safety. International Chemical Safety Card entry for Arsine. ICSC 0222, 2001. World Health Organization: Geneva.</p> |

Stibine

| | |
|---|--|
| CAS number | 7803-52-3 |
| Molecular weight | 125 |
| Formula | SbH ₃ |
| Common synonyms | Antimony hydride, Antimony trihydride, Hydrogen antimonide |
| State at room temperature | Gas |
| Volatility | Vapour pressure >760mm Hg at 20°C |
| Vapour density | 4.4 (air = 1) |
| Flammability | Extremely flammable |
| Lower explosive limit | Limits not known |
| Upper explosive limit | Limits not known |
| Water solubility | Poor |
| Reactivity | Stibine reacts violently with chlorine, concentrated nitric acid and ozone causing risk of fire and explosion |
| Reaction or degradation products | Decomposes slowly at room temperature but quickly when heated to 200°C, to form metallic antimony and hydrogen gas |
| Odour | Resembles rotten eggs (hydrogen sulphide) |
| Structure |  |
| References | <p>Stibine (IBM HAZARDTEXT ®) In: IBM Micromedex® TOMES® System (electronic version). Truven Health Analytics, Greenwood Village, Colorado, USA. Available at: http://www.micromedexsolutions.com/ (accessed 05/2018).</p> <p>Hazardous Substances Data Bank. Stibine HSDB No. 785 (last revision date 24/06/2005). US National Library of Medicine: Bethesda MD. http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB (accessed 05/2018).</p> <p>International Programme on Chemical Safety. International Chemical Safety Card entry for Stibine. ICSC 0776, 2008. World Health Organization: Geneva.</p> |

Reported Effect Levels from Authoritative Sources

Exposure by inhalation

Arsine

| ppm | mg/m ³ | Signs and symptoms | Reference |
|-------|-------------------|--|-----------|
| 3-10 | 10-32 | Exposure may result in symptoms (malaise, dizziness, nausea, abdominal pain, and dyspnea) within a few hours | a |
| 25-50 | 81-162 | Lethal (30 minute exposure) | b |
| 250 | 810 | Instantly lethal | b |

These values give an indication of levels of exposure that can cause adverse effects. They are not health protective standards or guideline values

Note
The effects of stibine are likely to be similar to those of arsine but not necessarily at the same concentrations

References

a AIHA. 1999. Emergency response planning guidelines: Arsine. Fairfax, VA: American Industrial Hygiene Association.

b International Programme on Chemical Safety, Poisons Information Monographs 044: Arsine.

Published Emergency Response Guidelines

Emergency response planning guideline (ERPG) values

Arsine

| | Listed value (ppm) | Calculated value (mg/m ³) |
|---------------------|--------------------|---------------------------------------|
| ERPG-1* | NA | - |
| ERPG-2 [†] | 0.5 | 1.6 |
| ERPG-3 [‡] | 1.5 | 4.8 |

* Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined, objectionable odour

[†] Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action

[‡] Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects

NA Not appropriate

Reference
American Industrial Hygiene Association (AIHA). 2016 Emergency Response Planning Guideline Values.
<https://www.aiha.org/get-involved/AIHAGuidelineFoundation/EmergencyResponsePlanningGuidelines/Documents/2016%20ERPG%20Table.pdf>
(accessed 05/2018).

Stibine

| | Listed value (ppm) | Calculated value (mg/m ³) |
|---------------------|--------------------|---------------------------------------|
| ERPG-1* | ID | - |
| ERPG-2 [†] | 0.5 | 2.55 |
| ERPG-3 [‡] | 1.5 | 7.65 |

* Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined, objectionable odour

[†] Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action

[‡] Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects

ID insufficient data

Reference
American Industrial Hygiene Association (AIHA). 2016 Emergency Response Planning Guideline Values.
<https://www.aiha.org/get-involved/AIHAGuidelineFoundation/EmergencyResponsePlanningGuidelines/Documents/2016%20ERPG%20Table.pdf>
(accessed 05/2018).

Acute exposure guideline levels (AEGLs)

| Arsine | ppm | | | | |
|---------------------------|--------|--------|--------|---------|---------|
| | 10 min | 30 min | 60 min | 4 hours | 8 hours |
| AEGL-1* | NR | NR | NR | NR | NR |
| AEGL-2[†] | 0.3 | 0.21 | 0.17 | 0.04 | 0.02 |
| AEGL-3[‡] | 0.91 | 0.63 | 0.5 | 0.13 | 0.06 |

* Level of the chemical in air at or above which the general population could experience notable discomfort
† Level of the chemical in air at or above which there may be irreversible or other serious long-lasting effects or impaired ability to escape
‡ Level of the chemical in air at or above which the general population could experience life-threatening health effects or death
NR not recommended since AEGL-2 concentrations are below sensory effect concentrations

Reference
US Environmental Protection Agency. Acute Exposure Guideline Levels. <http://www.epa.gov/oppt/aegl/pubs/chemlist.htm> (accessed 05/2018).

| Stibine | ppm | | | | |
|---------------------------|--------|--------|--------|---------|---------|
| | 10 min | 30 min | 60 min | 4 hours | 8 hours |
| AEGL-1* | NR | NR | NR | NR | NR |
| AEGL-2[†] | 4.2 | 2.9 | 1.5 | 0.36 | 0.18 |
| AEGL-3[‡] | 28 | 19 | 9.6 | 2.4 | 1.2 |

* Level of the chemical in air at or above which the general population could experience notable discomfort
† Level of the chemical in air at or above which there may be irreversible or other serious long-lasting effects or impaired ability to escape
‡ Level of the chemical in air at or above which the general population could experience life-threatening health effects or death
NR not recommended due to insufficient data

Reference
US Environmental Protection Agency. Acute Exposure Guideline Levels. <http://www.epa.gov/oppt/aegl/pubs/chemlist.htm> (accessed 05/2018).

Exposure Standards, Guidelines or Regulations

Occupational standards

| Arsine | LTEL (8-hour reference period) | | STEL (15-min reference period) | |
|------------|--------------------------------|-------------------|--------------------------------|-------------------|
| | ppm | mg/m ³ | ppm | mg/m ³ |
| WEL | 0.05 | 0.16 | - | - |

WEL – workplace exposure limit, LTEL – long-term exposure limit, STEL – short-term exposure limit

Reference
Health and Safety Executive (HSE). EH40/2005 Workplace Exposure Limits, 3rd Edition, 2018.

Public health guidelines

| | |
|---|---------------------------|
| Drinking water standard WHO guideline value | Values not given |
| Air quality guideline | Guideline value not given |
| Soil guideline values and health criteria values | Guideline value not given |

Health Effects

Major route of exposure

- arsine is extremely toxic by inhalation, even at concentrations below the odour threshold
- the health effects of arsine and stibine are similar

Immediate signs or symptoms of acute exposure

Arsine

| Route | Signs and symptoms |
|--|---|
| Inhalation | <p>The onset of features is often delayed for several hours. Features include headache, malaise, thirst, dizziness, shivering and breathlessness followed by nausea and vomiting, abdominal pain, paraesthesiae/dysaesthesiae and severe haemolysis. Weakness with muscle cramps and occasionally hypotension may occur</p> <p>Can cause severe acute haemolysis, renal failure and can kill rapidly</p> <p>Painless dark red urine (due to the presence of haemoglobin) generally develops within 4-6 hours of exposure. Bronze/orange discolouration of the skin and orange-red staining of the conjunctiva and sclera may occur as a result of haemolysis and is probably due to the presence of circulating degradation products of haemoglobin in plasma</p> <p>After 24–48 hours, fever, anaemia, jaundice, enlargement of the liver, hyperkalaemia, prolongation of the prothrombin time and pulmonary oedema may ensue</p> <p>Investigations may show peaked T-wave on ECG most probably secondary to hyperkalaemia, leucocytosis and reticulocytosis. Hyperbilirubinemia, an increase in serum LDH concentration and a reduced haptoglobin concentration are present in patients with significant haemolysis</p> <p>Acute hepatic and renal failure may occur</p> <p>There may be mild methemoglobinemia</p> <p>Peripheral neuropathy with weakness, myalgia and paraesthesia may be delayed and persist. Horizontal white lines on the nails (Mees' lines) may appear</p> |
| Dermal | Superficial cutaneous desquamation of exposed skin has occurred |
| Ocular | Potential irritant which can cause lacrimation. Orange-red staining of the sclerae occurs when haemolysis is present |
| <p>Reference TOXBASE. Arsine, 12/2017 http://www.toxbase.org (accessed 05/2018).</p> | |

Decontamination at the Scene

The approach used for decontamination at the scene will depend upon the incident, location of the casualties and the chemicals involved. Therefore, a risk assessment should be conducted to decide on the most appropriate method of decontamination.

Decontamination may not be necessary following exposure to arsine and stibine as they exist as gases at room temperature. These gases may be stored as liquid under pressure in cylinders for industrial use; this liquid will rapidly volatilise on release, though it may cause thermal burns on contact with skin.

Emergency services and public health professionals can obtain further advice from Public Health England (Centre for Radiation, Chemical and Environmental Hazards) using the 24-hour chemical hotline number: 0344 892 0555.

Clinical Decontamination and First Aid

Clinical decontamination is the process where trained healthcare professionals using purpose-designed decontamination equipment treat contaminated people individually.

Detailed information on clinical management can be found on TOXBASE – www.toxbase.org.

Important note

Once body surface contaminants have been removed or if your patient was exposed by ingestion or inhalation the risk that secondary care givers may become contaminated is very low. Secondary carers should wear standard hospital PPE as a precaution against secondary contamination from vomit and body fluids. Care should be given in a well ventilated area.

Clinical decontamination following surface contamination

- carry out decontamination after resuscitation. This should be performed in a well-ventilated area preferably with its own ventilation system
- contaminated clothing should be removed, double-bagged, sealed and stored safely
- decontaminate open wounds first and avoid contamination of unexposed skin. Any particulate matter adherent to skin should be removed and the patient washed with soap and water under low pressure for at least 10-15 minutes
- pay particular attention to mucous membranes, moist areas such as skin folds, fingernails and ears. The earlier irrigation begins, the greater the benefit

Dermal exposure

- if required decontaminate the patient (as above) following surface contamination
- other supportive measures as indicated by the patient's clinical condition

Ocular exposure

- if eye irritation is present, immediately irrigate the affected eye thoroughly with water or 0.9% saline for at least 10-minutes
- other supportive measures as indicated by the patient's clinical condition

Inhalation

- maintain a clear airway and ensure adequate ventilation
- give oxygen
- monitor vital signs, cardiac rhythm and check capillary blood sugar
- perform 12-lead ECG in all patients who require assessment

- other supportive measures as indicated by the patient's clinical condition

Health effects and decontamination references

TOXBASE <http://www.toxbase.org> (accessed 05/2018)

TOXBASE Arsine, 01/2012

TOXBASE Skin decontamination – irritants, 01/2018

This document from the PHE Centre for Radiation, Chemical and Environmental Hazards reflects understanding and evaluation of the current scientific evidence as presented and referenced here.

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