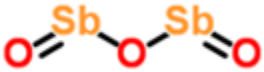
# EHS Summary of Antimony for the MA TURA Science Advisory Board Meeting – September 2023

## Antimony use as/with flame retardants

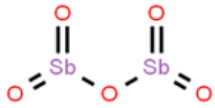
Antimony is used as a synergist in conjunction with halogenated chemicals for flame retardancy. Therefore, antimony could be used in any polymeric product (textile, foam, resin, etc) along with a halogenated FR, or by itself in a halogenated polymer (e.g., PVC).

The primary compound used for flame retardancy is antimony trioxide (ATO*). The flame retarding effect of antimony trioxide is produced by the formation of halogenated antimony compounds, which react with hydrogen atoms, and probably also with oxygen atoms and OH radicals, thus inhibiting fire.*

**The specific CAS number listed in the MA FR law is antimony trioxide (CAS 1309–64–4, oxidation state +3)**




**Proposed Analogue 1 is antimony pentoxide (1314-60-9, oxidation state +5).**




**Proposed Analogue 2 is sodium antimonate (33908-66-6, oxidation state +5)**


## Antimony oxidation states

Antimony displays 4 oxidations states:

- -3, antimonides, e.g. silver antimonide
- 0 Antimony (metal) Sb 7440-36-0
- **+3 antimony trioxide, most commonly used as FR in plastics,** and can be formed when Sb is burnt in air, and antimony pentasulfide 1315-04-4
- +5 antimony pentoxide is most common in the environment

Antimony can change oxidation state under environmental conditions: ASTDR 2019: Toxicological Profile for Antimony and Compounds, p. 1 "Antimony is predominantly in the +5 oxidation state in both aerobic freshwater and seawater. These waters also contain antimony in the +3 oxidation state to a lesser extent. Trivalent antimony is the dominant oxidation state of antimony in anaerobic environments. The predominant trivalent species in the environment is antimony trihydroxide ($Sb(OH)_3$) and the predominant pentavalent species is hexahydroxoantimonate ($Sb(OH)_6^-$), as predicted by thermodynamic calculations (Bodek et al. 1988)."

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"Antimony can be reduced and methylated by microorganisms in anaerobic sediment, releasing volatile methylated antimony compounds into the water. Multiple microorganisms have been found to methylate antimony in the soil and water and other anaerobic environments (Bentley and Chasteen 2002)."

Also Ji et al 2018. *Uptake and Transformation of Methylated and Inorganic Antimony in Plants* (focused on Sb in soils on shooting ranges) "Under aerobic conditions, the dominant species is Sb(V) occurring as the anion Sb(OH)− 6 in soil solution, while under reducing conditions it is Sb(III) occurring as Sb(OH)3. Many soils are periodically or occasionally flooded or waterlogged, so that redox conditions can vary between aerobic to anaerobic due to a lack of oxygen. A change in redox state from Sb(V) to Sb(III) can have a strong effect on Sb uptake by plants."

## "Antimony compounds" as a category

Existing justification for considering all antimony compounds as having similar hazard:

- "Antimony compounds" are one category in the following programs: EPA TRI, EPA air toxics, TURA
- Listed on Washington state Chemicals of High Concern to Children list (7440-36-0 Antimony & Antimony compounds)

Conversely, CA Prop 65 relies on the IARC authoritative body listing, and only lists antimony oxide (antimony trioxide)

## Chronic Aquatic Toxicity of Antimony Compounds

Following is Cheminformatics data on antimony trioxide, antimony pentoxide and sodium antimonate. All three antimony compounds share the "very high" rating for chronic aquatic toxicity with NOEC or LOEC <1 mg/L. See 'hazard records' tab in Cheminformatics file in LibGuide.

Chemicals: 3 — *Toxicity:* VH - Very High H - High M - Medium L - Low I - Inconclusive N/A - Not Applicable *Authority:* **Authoritative** Screening *QSAR Model*

Skipped (0) Unlikely (0) Filters (0) Sorting (0) Structure

| CAS / Name | Human Health Effects: Acute Mammalian Toxicity: Oral | Acute Mammalian Toxicity: Inhalation | Acute Mammalian Toxicity: Dermal | Carcinogenicity | Genotoxicity Mutagenicity | Endocrine Disruption | Reproductive | Developmental | Neurotoxicity: Repeat Exposure | Neurotoxicity: Single Exposure | Systemic Toxicity: Repeat Exposure | Systemic Toxicity: Single Exposure | Skin Sensitization | Skin Irritation | Eye Irritation | Ecotoxicity: Acute Aquatic Toxicity | Ecotoxicity: Chronic Aquatic Toxicity | Fate: Persistence | Fate: Bioaccumulation | Fate: Exposure |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1309-64-4 IGBTP Antimony trioxide | L | I | L | **VH** | VH | | L | L | | | **L** | M | I | H | H | **L** | **VH** | | L | |
| 1314-60-9 GBT Antimony pentoxide | L | I | I | I | I | | I | I | I | I | **H** | I | I | I | I | H | VH | | L | |
| 33908-66-6 GBT Sodium hexahydr… | L | I | | | I | | | | | | | | | | | H | VH | | L | |

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## Antimony Trioxide Carcinogenicity

NTP Report on Carcinogens, Fifteenth Edition, 2021 recommends that antimony trioxide is *reasonably anticipated to be a human carcinogen* based on *sufficient* evidence of carcinogenicity from studies in experimental animals and supporting evidence from mechanistic studies. The data available from studies in humans are *inadequate* to evaluate the relationship between human cancer and exposure specifically to $Sb_2O_3$ or antimony in general.

## Summary of Additional Health Effects (ATSDR, 2019)

"Toxic side effects in humans following intraperitoneal, intravenous, or intramuscular injection of an antimony-containing drug have been reported, including altered electrocardiograms (EKGs), vomiting, diarrhea, and joint and/or muscle pain.." " These side effects are more frequently observed following administration of **trivalent antimony** compounds, especially antimony potassium tartrate or antimony sodium tartrate; side effects have also been found in humans administered **pentavalent** organic compounds such as sodium antimony gluconate or meglumine antimoniate"(p. 13)

Particularly for trivalent compounds, the most sensitive targets appear to be the respiratory tract, heart, gastrointestinal tract, serum glucose, and developing animal

- Respiratory effects following inhalation exposure are a presumed health effect for humans
- Myocardial effects and EKG alterations are a suspected health effect for humans
- Gastrointestinal effects are a presumed health effect for humans
- Developmental effects are a suspected health effect for humans
- Alterations in blood glucose levels are a suspected health effect for humans

## Additional Health Effects Excerpts from ASTDR, 2019

P. 6 cardiovascular effects

"These findings are supported by reports of altered EKG readings (particularly prolongation of the QT interval) in individuals exposed to repeated injections of antimony (Dancaster et al. 1966; Honey 1960; Pandey et al. 1988) and in experimental studies in laboratory animals injected with **trivalent or pentavalent** antimony compounds (Alvarez et al. 2005; Bromberger-Barnea and Stephens 1965; Cotten and Logan 1966)."

> p. 62 "…Similar findings were observed in myocytes exposed to pentavalent antimony, although the investigators concluded that this was **likely due to the conversion of pentavalent antimony to trivalent** antimony. Pentavalent antimony also increased sodium current amplitude, which was not observed in trivalent antimony exposed myocytes."

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p. 6 developmental effects

"…decreases in birth weight or fetal weight were observed in rats administered organic **pentavalent** antimony compounds via subcutaneous or intramuscular injection (Alkhawajah et al. 1996; Coelho et al. 2014a; Miranda et al. 2006)"

p. 7 blood glucose levels

"…decreased blood glucose levels in rats administered intramuscular injections of organic **pentavalent** compounds (Alkhawajah et al. 1992)."

p. 13

"**Health effects data for all antimony compounds are discussed together in this chapter. There is some evidence of compound-specific differences in toxicity that are likely reflective of toxicokinetic differences, particularly differences in the relative absorption of the compounds. When relevant, these differences are discussed.** Concentrations and doses in the tables and text have been calculated from the investigated compound to the elemental antimony in order to facilitate comparisons between studies"