

IX. APPENDIX I

METHODS FOR SAMPLING ANTIMONY IN AIR

General Requirements

(a) Collect air samples representative of the breathing zones of individual workers to characterize the exposure from each job or specific operation in each work area.

(1) Collect samples as near as practicable to the face of workers without interfering with freedom of movement.

(2) Collect samples to permit determination of exposures for every job involving antimony in sufficient numbers to express the variability of the exposures for the work situation.

(b) Suggested records:

(1) Date and time of sample collection;

(2) Sampling rate and duration;

(3) Total sample volume;

(4) Location of sampling;

(5) Temperature, pressure, and relative humidity at time of sampling; and

(6) Other pertinent information regarding worker and work setting.

Sampling for Particulate Antimony and Compounds

(a) The sampling equipment consists of:

(1) A portable, battery-operated personal sampling pump calibrated to $\pm 5\%$ of the required flowrate.

(2) A 2-or 3-piece filter cassette containing an 0.8- μm cellulose ester membrane filter (Millipore type AA, or equivalent) supported by a cellulose backup pad for collecting the sample.

(b) The sampling rate must be accurately ($\pm 5\%$) maintained at the target value, which should lie within the range of 1.5-2.5 liters/minute. Samples should be taken for a time period that will provide at least 2.5 μg Sb in the sample.

(c) Upon completion of sampling, plastic plugs are replaced on the inlet and outlet openings of the cassette and an appropriate identification is attached. A minimum of four samples are taken for each operation and averaged

on a time-weighted basis. Note the suspected identities of all substances present in the air sample.

(d) To determine background correction, a field blank and a laboratory blank are analyzed along with the samples. The field blank is a filter that is handled in exactly the same manner as the samples (ie, placed in a cassette) except that no air is drawn through it. The laboratory blank is a clean, unused filter which has not been handled.

Sampling for Volatile Antimony Compounds

(a) The sampling equipment consists of:

(1) A prefilter unit (if needed), consisting of an 0.8- μ m membrane filter in a cassette filter holder. Possible interactions between reactive, volatile antimony compounds and the prefilter may cause erroneously low readings in the impinger sample.

(2) A midget impinger containing 10 ml of absorbing solution. The absorbing solution is made by dissolving 50 g mercuric chloride in 1 liter of 6N hydrochloric acid.

(3) A personal sampling pump capable of calibration to +5% of the required flowrate, which should be 1.5-2.5 liters per minute.

(4) The sampling pump is protected from splashover or water condensation by an absorption tube loosely packed with glass wool and inserted between the exit arm of the impinger and the pump. Connect the impinger via the absorption tube to the pump and the prefilter assembly (if needed) with a short piece of nonrubber, flexible tubing. The air being sampled should not be passed through any other tubing or other equipment before entering the impinger.

(b) After sampling, remove the impinger stem and rinse it with 2 or 3 ml of distilled-deionized water, collecting the rinsings in the impinger. The impinger is then sealed with a nonreactive stopper, such as Teflon. Do not use a rubber stopper. If it is preferred to store or ship the impinger with the stem in, the openings should be sealed with an inert film or other nonrubber cover, and the ground glass joint should be taped securely. Care should be taken to minimize spillage or loss by evaporation at all times.

(c) A "blank" impinger should be handled in the same manner as the samples (ie, fill, seal, transport, and analyze) except that no air is sampled through it.

(d) Where a prefilter has been used, the filter cassettes are capped and appropriately identified. The prefilter, along with blank filters, is analyzed for particulate antimony and antimony compounds.

(e) Samples should be collected so as to contain at least 2.5 μ g Sb if analysis is to be by the flameless method. If the flame method is used, at least 50 μ g Sb should be collected.

Calibration of Equipment

Since the accuracy of an analysis can be no greater than the accuracy with which the volume of air is measured, the accurate calibration of the sampling pump is essential. The frequency of calibration required depends on the use, care, and handling to which the pump is subjected. Pumps should be calibrated initially and recalibrated if they have been abused or repaired. Regardless of use, maintenance and calibration should be performed on a routine schedule, and records of these should be kept.

The accuracy of calibration depends on the type of instrument used for calibration. The choice of instrument will depend largely on where the calibration is to be performed. For laboratory testing, a spirometer or soapbubble meter is recommended, although other calibration instruments, such as a wet test meter, dry gas meter, or rotameter can be used. For field testing, calibration as necessary using a rotameter is recommended. Since the flowrate given by a pump depends on the pressure drop across the sampling device, the pump must be calibrated while operating with a representative filter in line.

X. APPENDIX II

ANALYTICAL METHODS FOR ANTIMONY

Method for Particulates

A known volume of air is drawn through a membrane filter to collect particulate matter. The residue obtained from digesting the collected particulate matter in a mixture of nitric, perchloric, and sulfuric acids is diluted with distilled water; aliquots are analyzed for antimony at 217.6 nm by flameless atomic absorption. If lead is present in the sample, the 231.2-nm resonance line is used.

Method for Volatile Antimony Compounds

Air samples collected in impinger solutions are analyzed directly by flameless atomic absorption.

Range and Sensitivity

The analytical range is 0.05-1.0 mg of antimony/cu m for a 50-liter air sample diluted to 50 ml for particulates and 25 ml for volatile compounds; a 25- μ l aliquot is used for analysis. This range corresponds to 2.5-50 μ g Sb in the collected sample. The analytical range may be extended by altering the dilution volume or the size of the analytical aliquot.

Sensitivity varies with different instruments, graphite tubes, and sample matrices. NIOSH has found a sensitivity of 125 pg Sb/1% absorbance in ashed filter solutions and 250 pg Sb/1% absorbance in 5% HgCl₂/6N HCl. Sensitivity may be increased 5-fold over these values by using the purge-gas interrupt mode.

Interferences

(a) Lead in the sample will absorb at 217.0 nm and may interfere at 217.6 nm if the reading power of the instrument is not adequate.

(b) Flameless atomic absorption is prone to matrix effects; standard addition methods can be used to evaluate such interferences.

Precision and Accuracy

The performance characteristics of the method as found by NIOSH are discussed in subsections (a) and (b).

(a) The pooled coefficient of variation for the analysis of five calibration solutions (10 determinations each) covering the range (0.05-1.0 μ g/ml) was 0.038.

(b) The recoveries of antimony from filters spiked with 5.0, 12.5, and 25.0 μg Sb/filter were 100 \pm 3.9%, 99.3 \pm 2.9%, and 98.7 \pm 3.2%, respectively. The pooled coefficient of variation was 0.034.

Advantages of the Flameless Method

(a) It is approximately 50-100 times more sensitive than conventional flame atomic absorption.

(b) It requires fewer operations on the sample and has a lower coefficient of variation than hydride generation techniques.

Disadvantages of the Flameless Method

Matrix effects are more prevalent than with conventional flame atomic absorption.

Apparatus

(a) Atomic absorption spectrophotometer with graphite atomizer and deuterium or hydrogen continuum correction.

(b) Hollow cathode or electrodeless discharge lamp for antimony (wavelength, 217.6 nm).

(c) Argon, high purity, in a cylinder equipped with a two-stage pressure regulator and appropriate hose connections.

(d) Variable temperature hotplate capable of reaching 350 C.

(e) Perchloric acid fume hood.

(f) Borosilicate glassware, including:

(1) Phillips beakers with watchglass covers (125 ml);

(2) Volumetric flasks, (50 and 100 ml);

(3) Volumetric pipets, (1, 5, and 10 ml);

(4) Micro-pipets, (10, 25, 50 and 100 μl);

(5) Small test tubes (10 ml).

Reagents

(a) Double distilled or deionized water.

(b) Nitric acid, concentrated, analytic reagent grade, redistilled in glass.

- (c) Perchloric acid, 70%, analytic reagent grade.
- (d) Sulfuric acid, 98%, analytic reagent grade.
- (e) Ashing acid, (3:1:1, nitric:perchloric:sulfuric).
- (f) Antimony stock solution containing antimony at 1,000 $\mu\text{g}/\text{ml}$.
- (g) Mercuric chloride (HgCl_2).
- (h) Hydrochloric acid, 6N , redistilled (constant-boiling HCl is approximately 6N).

Procedure

(a) Cleaning of Equipment

(1) Before first use, clean all glassware with a detergent solution, followed in order by rinsing with water, rinsing with distilled water, soaking 30 minutes in concentrated nitric acid, and thorough rinsing in distilled water.

(2) Glassware used exclusively for antimony analysis may be cleaned by soaking for 30 minutes in dilute nitric acid followed by thorough rinsing in distilled water.

(b) Analysis of Samples

(1) Place sample filters and blank filters in 125-ml Phillips beakers, add 5 ml of ashing acid, cover with a watchglass and heat at 140 C on a hotplate for 2 hours. Increase the temperature to 200 C and reduce the volume of solution to approximately 2 ml. Complete digestion is indicated by a nearly colorless residual solution. Additional small amounts (1 ml) of nitric acid may be added and evaporated to complete digestion. Remove the watchglass and raise the temperature to 350 C until the evolution of sulfur trioxide is complete and the residual volume is reduced to 0.5 ml. Do not allow the solution to evaporate to dryness. Cool, then add 1 ml of H_2SO_4 , transfer quantitatively to a volumetric flask, and dilute to volume with distilled water.

(2) For impinger samples, quantitatively transfer the contents of the impinger to a 25-ml volumetric flask. Dilute to volume with distilled water.

(3) Analyze triplicate aliquots of sample solution for antimony by flameless atomic absorption using the manufacturer's recommended operating conditions except for drying, charring, and atomizing times and temperatures. For these, use the following:

- (A) Dry for 30 seconds at 110 C;
- (B) Char for 20 seconds at 700 C; and
- (C) Atomize for 8 seconds at 2,700 C.

(4) Analyze triplicate aliquots of standard solutions, at least one standard analysis for three sample analyses.

(c) Determine the concentration of antimony present in the sample from a standard curve or by standard addition, as indicated below.

(1) Standard Curve

(A) For analysis of particulate samples, prepare at least five standard solutions containing a series of concentrations of antimony within the analytical range of the method. Prepare the final dilutions by transferring the required aliquot to 3 ml of sulfuric acid and diluting to 100 ml with distilled water.

(B) For analysis of volatile compounds, prepare at least five standard solutions containing a series of concentrations of antimony within the analytical range of the method. The concentration of the Cl_2 and HCl in the standards should be made identical to those in the samples by diluting 10 ml of 5% HgCl_2 in 6N HCl to 25 ml with distilled water after adding an appropriate amount of antimony stock solution. Prepare a blank solution by diluting 10 ml of 5% $\text{HgCl}_2/6\text{N HCl}$ to 25 ml with distilled water.

(C) Determine absorbance of the standard solutions and subtract the absorbance of the blank solution from each.

(D) Prepare a calibration curve by plotting absorbance vs concentration of antimony in $\mu\text{g/ml}$.

(E) From the peak absorbance of the samples, subtract the absorbance of the filter blank to determine the corrected sample absorbance. Compare the corrected sample absorbance with the calibration curve to determine the amount of antimony, in $\mu\text{g/ml}$, in the sample solution.

The concentration of antimony in air is calculated as follows:

$$C = \mu\text{g Sb/ml} \times \frac{V}{V_s}$$

where:

C = Concentration of antimony (mg Sb/cu m)

$\mu\text{g Sb/ml}$ = Concentration determined from the calibration curve

V = Volume of diluted solution (ml)

V_s = Volume of air samples (liters)

(2) Standard Addition

(A) To a series of at least three test tubes containing equal aliquots (5 ml) of the sample solution, add, to all but one, aliquots of a standard antimony solution graded to contain multiples, such as 0.5, 1, 2, and 3, of the amount of antimony estimated to be present in the sample aliquots. Make the final volume in all test tubes equal by adding distilled water. Prepare a similar set of test tubes starting with equal aliquots (5 ml) of the

filter blank solution. All concentrations of antimony must fall within the linear portion of the standard curve; otherwise the standard addition is invalid.

(B) Analyze triplicate aliquots of each of these sample and blank solutions.

(C) Plot the absorbance values for the sample solutions and the spiked sample solutions against an abscissa labeled " μg of Sb added/ N ml." Draw the best straight line through the points. The intercept of this line on the negative abscissa (0.0 absorbance units) is read as the concentration in $\mu\text{g}/N$ ml of antimony in the sample solution. The concentration is converted to $\mu\text{g}/\text{ml}$ by multiplying by N . Subtract the concentration, if any, in $\mu\text{g}/\text{ml}$ for the blank from the samples. Convert to mg Sb/cu m.

If the result of this determination is not within 10% of the values obtained from the standard curve, an interference is indicated and standard addition techniques should be utilized for sample analysis.

XI. APPENDIX III

MATERIAL SAFETY DATA SHEET

General instructions for preparing a Material Safety Data Sheet (MSDS) are presented in this appendix. The examples used in the text are for illustrative purposes and are not intended to apply to any specific compound or product. Applicable information about a specific product or material shall be supplied in the appropriate block of the MSDS.

The product designation is inserted in the block in the upper left corner of the first page to facilitate filing and retrieval. Print in upper case letters as large as possible. It should be printed to read upright with the sheet turned sideways. The product designation is that name or code designation which appears on the label, or by which the product is sold or known by employees. The relative numerical hazard ratings and key statements are those determined by the guidelines in Chapter V, Part B, of the NIOSH publication, An Identification System for Occupationally Hazardous Materials. The company identification may be printed in the upper right corner if desired.

(a) Section I. Product Identification

The manufacturer's name, address, and regular and emergency telephone numbers (including area code) are inserted in the appropriate blocks of Section I. The company listed should be a source of detailed backup information on the hazards of the material(s) covered by the MSDS. The listing of suppliers or wholesale distributors is discouraged. The trade name should be the product designation or common name associated with the material. The synonyms are those commonly used for the product, especially formal chemical nomenclature. Every known chemical designation or competitor's trade name need not be listed.

(b) Section II. Hazardous Ingredients

The "materials" listed in Section II shall be those substances which are part of the hazardous product covered by the MSDS and individually meet any of the criteria defining a hazardous material. Thus, one component of a multicomponent product might be listed because of its toxicity, another component because of its flammability, while a third component could be included both for its toxicity and its reactivity. Note that a MSDS for a single component product must have the name of the material repeated in this section to avoid giving the impression that there are no hazardous ingredients.

Chemical substances should be listed according to their complete name derived from a recognized system of nomenclature. Where possible, avoid using common names and general class names such as "aromatic amine," "safety solvent," or "aliphatic hydrocarbon" when the specific name is known.

The "%" may be the approximate percentage by weight or volume (indicate basis) which each hazardous ingredient of the mixture bears to the whole

mixture. This may be indicated as a range or maximum amount, ie, "10-40% vol" or "10% max wt" to avoid disclosure of trade secrets.

Toxic hazard data shall be stated in terms of concentration, mode of exposure or test, and animal used, eg, "100 ppm LC50-rat," "25 mg/kg LD50-skin-rabbit," "75 ppm LC man," or "permissible exposure from 29 CFR 1910.1000," or, if not available, from other sources of publications such as the American Conference of Governmental Industrial Hygienists or the American National Standards Institute Inc. Flashpoint, shock sensitivity or similar descriptive data may be used to indicate flammability, reactivity, or similar hazardous properties of the material.

(c) Section III. Physical Data

The data in Section III should be for the total mixture and should include the boiling point and melting point in degrees Fahrenheit (Celsius in parentheses); vapor pressure, in conventional millimeters of mercury (mmHg); vapor density of gas or vapor (air = 1); solubility in water, in parts/hundred parts of water by weight; specific gravity (water = 1); percent volatiles (indicate if by weight or volume) at 70 F (21.1 C); evaporation rate for liquids or sublimable solids, relative to butyl acetate; and appearance and odor. These data are useful for the control of toxic substances. Boiling point, vapor density, percent volatiles, vapor pressure, and evaporation are useful for designing proper ventilation equipment. This information is also useful for design and deployment of adequate fire and spill containment equipment. The appearance and odor may facilitate identification of substances stored in improperly marked containers, or when spilled.

(d) Section IV. Fire and Explosion Data

Section IV should contain complete fire and explosion data for the product, including flashpoint and autoignition temperature in degrees Fahrenheit (Celsius in parentheses); flammable limits, in percent by volume in air; suitable extinguishing media or materials; special firefighting procedures; and unusual fire and explosion hazard information. If the product presents no fire hazard, insert "NO FIRE HAZARD" on the line labeled "Extinguishing Media."

(e) Section V. Health Hazard Information

The "Health Hazard Data" should be a combined estimate of the hazard of the total product. This can be expressed as a TWA concentration, as a permissible exposure, or by some other indication of an acceptable limit. Other data are acceptable, such as lowest LD50, if multiple components are involved.

Under "Routes of Exposure," comments in each category should reflect the potential hazard from absorption by the route in question. Comments should indicate the severity of the effect and the basis for the statement, if possible. The basis might be animal studies, analogy with similar products, or human experiences. Comments such as "yes" or "possible" are not helpful. Typical comments might be:

Skin Contact--single short contact, no adverse effects likely; prolonged or repeated contact, irritation, and cracking.

Eye Contact--some pain and mild transient irritation; no corneal scarring.

"Emergency and First Aid Procedures" should be written in lay language and should primarily represent first-aid treatment that could be provided by paramedical personnel or individuals trained in first aid.

Information in the "Notes to Physician" section should include any special medical information which would be of assistance to an attending physician including required or recommended preplacement and periodic medical examinations, diagnostic procedures, and medical management of overexposed workers.

(f) Section VI. Reactivity Data

The comments in Section VI relate to safe storage and handling of hazardous, unstable substances. It is particularly important to highlight instability or incompatibility to common substances or circumstances such as water, direct sunlight, steel or copper piping, acids, alkalies, etc. "Hazardous Decomposition Products" shall include those products released under fire conditions. It must also include dangerous products produced by aging, such as peroxides in the case of some ethers. Where applicable, shelf life should also be indicated.

(g) Section VII. Spill or Leak Procedures

Detailed procedures for cleanup and disposal should be listed with emphasis on precautions to be taken to protect workers assigned to cleanup detail. Specific neutralizing chemicals or procedures should be described in detail. Disposal methods should be explicit including proper labeling of containers holding residues and ultimate disposal methods such as "sanitary landfill," or "incineration." Warnings such as "comply with local, state, and Federal antipollution ordinances" are proper but not sufficient. Specific procedures should be identified.

(h) Section VIII. Special Protection Information

Section VIII requires specific information. Statements such as "Yes," "No," or "If Necessary" are not informative. Ventilation requirements should be specific as to type and preferred methods. Specify respirators as to type and NIOSH or US Mine Safety and Health Administration approval class, ie, "Supplied air," "Organic vapor canister," "Suitable for dusts not more toxic than lead," etc. Protective equipment must be specified as to type and materials of construction.

(i) Section IX. Special Precautions

"Precautionary Statements" shall consist of the label statements selected for use on the container or placard. Additional information on any aspect of safety or health not covered in other sections should be inserted in Section

IX. The lower block can contain references to published guides or in-house procedures for handling and storage. Department of Transportation markings and classifications and other freight, handling, or storage requirements and environmental controls can be noted.

(j) Signature and Filing

Finally, the name and address of the responsible person who completed the MSDS and the date of completion are entered. This will facilitate correction of errors and identify a source of additional information.

The MSDS shall be filed in a location readily accessible to workers potentially exposed to the hazardous material. The MSDS can be used as a training aid and basis for discussion during safety meetings and training of new employees. It should assist management by directing attention to the need for specific control engineering, work practices, and protective measures to ensure safe handling and use of the material. It will aid the safety and health staff in planning a safe and healthful work environment and in suggesting appropriate emergency procedures and sources of help in the event of harmful exposure of employees.

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MATERIAL SAFETY DATA SHEET

I PRODUCT IDENTIFICATION		
MANUFACTURER'S NAME	REGULAR TELEPHONE NO EMERGENCY TELEPHONE NO	
ADDRESS		
TRADE NAME		
SYNONYMS		
II HAZARDOUS INGREDIENTS		
MATERIAL OR COMPONENT	%	HAZARD DATA
III PHYSICAL DATA		
BOILING POINT (760 MM HG)		MELTING POINT
SPECIFIC GRAVITY (H ₂ O=1)		VAPOR PRESSURE
VAPOR DENSITY (AIR=1)		SOLUBILITY IN H ₂ O, % BY WT
% VOLATILES BY VOL		EVAPORATION RATE (BUTYL ACETATE=1)
APPEARANCE AND ODOR		

IV FIRE AND EXPLOSION DATA				
FLASH POINT (TEST METHOD)			AUTOIGNITION TEMPERATURE	
FLAMMABLE LIMITS IN AIR, % BY VOL.		LOWER		UPPER
EXTINGUISHING MEDIA				
SPECIAL FIRE FIGHTING PROCEDURES				
UNUSUAL FIRE AND EXPLOSION HAZARD				
V HEALTH HAZARD INFORMATION				
HEALTH HAZARD DATA				
ROUTES OF EXPOSURE				
INHALATION				
SKIN CONTACT				
SKIN ABSORPTION				
EYE CONTACT				
INGESTION				
EFFECTS OF OVEREXPOSURE				
ACUTE OVEREXPOSURE				
CHRONIC OVEREXPOSURE				
EMERGENCY AND FIRST AID PROCEDURES				
EYES				
SKIN				
INHALATION				
INGESTION				
NOTES TO PHYSICIAN				

VI REACTIVITY DATA	
CONDITIONS CONTRIBUTING TO INSTABILITY	
INCOMPATIBILITY	
HAZARDOUS DECOMPOSITION PRODUCTS	
CONDITIONS CONTRIBUTING TO HAZARDOUS POLYMERIZATION	
VII SPILL OR LEAK PROCEDURES	
STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED	
NEUTRALIZING CHEMICALS	
WASTE DISPOSAL METHOD	
VIII SPECIAL PROTECTION INFORMATION	
VENTILATION REQUIREMENTS	
SPECIFIC PERSONAL PROTECTIVE EQUIPMENT	
RESPIRATORY (SPECIFY IN DETAIL)	
EYE	
GLOVES	
OTHER CLOTHING AND EQUIPMENT	

IX SPECIAL PRECAUTIONS

PRECAUTIONARY
STATEMENTS

OTHER HANDLING AND
STORAGE REQUIREMENTS

PREPARED BY _____

ADDRESS _____

DATE _____

XII. TABLES

TABLE XII-1

PHYSICAL AND CHEMICAL PROPERTIES OF ANTIMONY AND SOME OF ITS INORGANIC COMPOUNDS

Substance	Formula Weight	SG*	Melting Point C	Boiling Point C	Temperature for 1 mm Hg Vapor Pressure	Solubility Data, Solvent and Degree**
<u>Solids at STP</u>						
Antimony (Sb)	121.76	6.68	630	1,380	886 C	Hot conc. H ₂ SO ₄ s Aqua regia s Dilute acids i
Antimony trioxide (Sb ₂ O ₃)	291.52	5.2	656	1,550	574 C	Hot water sl s Conc. HCl s Conc. H ₂ SO ₄ s KOH
Antimony pentoxide (Sb ₂ O ₅)	323.5	3.78	loses O at 380 C loses O ₂ at 930 C			Hot water i Cold water i Conc. HCl s KOH s
Antimony trisulfide (Sb ₂ S ₃)	339.7	4.64	550	1,150		Water i Hot water d Alkali s Conc. HCl s Sulfide solns s
Antimony pentasulfide (Sb ₂ S ₅)	403.82	4.12	75 d**			Hot water i Alkali s

TABLE XII-1 (CONTINUED)

PHYSICAL AND CHEMICAL PROPERTIES OF ANTIMONY AND SOME OF ITS INORGANIC COMPOUNDS

Substance	Formula Weight	SG*	Melting Point C	Boiling Point C	Temperature for 1 mm Hg Vapor Pressure	Solubility Data, Solvent and Degree**	
Antimony trichloride (SbCl ₃)	228.13	3.14	73.4	283	49.2 C (sublimes)	Alcohol Acetone Acids	i s s
Antimony trifluoride (SbF ₃)	178.8	4.38	292	319 (Sublimes)		Cold water Hot water NH ₃	385 5.6 i
<u>Liquids at STP</u>							
Antimony pentachloride (SbCl ₅)	299.05	2.34	2.8	79 (at 22 mm Hg)	22.7 C	Excess water HCl Chloroform	d s s
Antimony pentafluoride (SbF ₅)	216.76	2.99	7	149.5		Cold water KF	s s
<u>Gas at STP</u>							
Antimony hydride (SbH ₃)	124.78	4.34 (15 C, air=1)	-88	-17		Cold water Water 100 C	500 250

*SG-specific gravity

**s-soluble, sl s-slightly soluble, i-insoluble, d-decomposes; numerical values in g/100 ml

Adapted from references 131,224-26

TABLE XII-2

US INDUSTRIAL CONSUMPTION OF PRIMARY ANTIMONY IN 1976
BY CLASS OF MATERIAL PRODUCED

Product	Antimony Content (Short Tons)
Metal products	
Ammunition	63
Antimonial lead	3,861
Bearing metal and bearings	405
Cable covering	19
Castings	24
Collapsible tubes and foil	23
Sheet and pipe	74
Solder	188
Type metal	79
Other	164
Subtotal	4,900
Nonmetal products (excluding flame retardants)	
Ammunition primers	13
Fireworks	12
Ceramics and glass	1,260
Pigments	415
Plastics	1,277
Rubber products	578
Other	1,330
Subtotal	4,885
Flame retardants	
Plastics	3,777
Pigments	183
Rubber	199
Adhesives	141
Textiles	1,055
Paper	197
Subtotal	5,552
Total	15,337

Adapted from reference 2

TABLE XII-3

US INDUSTRIAL CONSUMPTION OF ANTIMONY IN 1976
BY CLASS OF MATERIAL CONSUMED

Material Consumed	Antimony Content (Short Tons)	End Use
Primary Antimony:		
Metal	3,375	Solder, type metal, ammunition, storage batteries, power transmission and communication equipment
Ore and concentrate	640	
Oxide	10,397	Glass products, rubber and plastics, textiles, chemicals, metalware
Sulfide	37	Pigments, plastics, ammunition, visual signaling, vulcanizing agent
Byproduct antimonial lead	697	Storage batteries, cable covering, printing and publishing, communications, ammunition
Residues	191	
Secondary Antimony:		
Antimonial lead and other alloys	19,799	Storage batteries, cable covering, printing and publishing, communications, ammunition

Adapted from references 1 and 2

TABLE XII-4

POTENTIALLY HAZARDOUS ANTIMONY COMPOUNDS

Chemical Name	Synonym
Antimony	Regulus of antimony, antimony regulus, stibium
Antimony arsenate	
Antimony arsenite	
Antimony dioxysulfate	
Antimony ethoxide	Triethyl antimonite
Antimony hydride	Stibine, antimonous hydride hydrogen antimonide
Antimony lactate	Antimonine, antimony salt of lactic acid
Antimony α -mercaptoacetamide	Antimony thioglycolamide
Antimony pyrogaliol	
Antimony oxychloride	Algaroth powder, antimonyl chloride, antimony chloride oxide, basic antimony chloride, mercurius vitae
Antimony oxysulfide	Cathusian powder, kermes mineral, kermesite, pyrostibonite antimony blend, sulfurated antimony
Antimony pentachloride	Antimony perchloride, butter of antimony, antimonie chloride
Antimony pentafluoride	Antimony fluoride
Antimony pentaiodide	Antimony iodide
Antimony pentasulfide	Antimony red, antimony sulfide, antimonial saffron, antimony persulfide, golden antimony sulfide
Antimony pentoxide	Antimonie anhydride, antimonie oxide, antimonie acid, antimonie pentoxide, stibic anhydride
Antimony potassium dimethylcysteine tartrate	
Antimony potassium oxalate	Potassium-antimony oxalate, potassium oxalatoantimonate
Antimony sodium dimethylcysteine tartrate	
Antimony sodium gluconate	Antimony gluconate complex sodium salt, antimony gluconate sodium, gluconic acid, antimony sodium derivative, sodium antimony gluconate, sodium stibogluconate, triostam, T.S.A.G.
Antimony sodium tartrate	Antimony sodium oxide L-tartrate, Emeto-Na, sodium antimonyl tartrate, stibunal
Antimony sodium thioglycollate	Antimony sodium thioacetate, mercaptoacetic acid
Antimony sulfate	Antimony salt of sulfuric acid, antimonous sulfate, antimony trisulfate
Antimony tetroxide	Antimony oxide

TABLE XII-4 (CONTINUED)

POTENTIALLY HAZARDOUS ANTIMONY COMPOUNDS

Chemical Name	Synonym
Antimony tribromide	Antimonous bromide, antimony bromide
Antimony trichloride	Antimonous chloride, butter of antimony, caustic antimony, mineral butter
Antimony trichloride solution	Antimony chloride solution, liquid butter of antimony
Antimony trifluoride	Antimonous fluoride, antimony fluoride
Antimony trioxide	Antimony white, flowers of antimony, antimony bloom, antimony oxide, black antimony, weisspiess-glanz
Antimony triiodide	Antimonous iodide, antimony iodide
Antimony triselenide	
Antimony trisulfide	Sulfuret of antimony, antimony orange, black antimony, antimony needles, antimonous sulfide, antimony glance, crimson antimony, gray antimony
Antimony tritelluride	Antimony telluride
Emetine antimony iodide	Antimony emetine iodide
Lead antimonate	Antimony yellow, Naples yellow
Oxo(tartrato)antimonate (1-)aniline	Aniline antimony tartrate, antimony aniline tartrate
Sodium antimonate	Antimony sodiate
Sodium antimonyl adonitol	
Sodium antimonyl D-arabitol	
Sodium antimonyl biscatechol	
Sodium antimonyl tert-butyl catechol	
Sodium antimonyl catechol thiosalicylate	Sodium antimonous-3-catechol thiosalicylate, stibsol
Sodium antimonyl citrate	
Sodium antimonyl erythritol	
Sodium antimonyl D-funcitol	
Sodium antimonyl gluco-guloheptitol	
Sodium antimonyl glycerol	
Sodium antimonyl 2,5-methylene D-mannitol	
Sodium antimonyl 2,4-methylene D-sorbitol	
Sodium antimonyl xylitol	

Adapted from reference 226

TABLE XII-5

OCCUPATIONS WITH POTENTIAL EXPOSURE TO ANTIMONY

Antimony ore smelters	Metal bronzers
Antimony workers	Miners
Babbitt metal workers	Monotypers
Battery workers, storage	Mordanters
Brass founders	Organic chemical synthesizers
Britannia metal workers	Paint makers
Bronzers	Painters
Burnishers	Perfume makers
Cable splicers	Pewter workers
Ceramic makers	Pharmaceutical workers
Compositors	Phosphor makers
Copper refiners	Pigment makers
Dye makers	Plaster cast bronzers
Electroplaters	Porcelain workers
Explosives makers	Pottery workers
Fireworks makers	Printers
Flame retardant workers	Pyrotechnics workers
Foundry workers	Rubber makers
Glass makers	Semiconductor workers
Glaze dippers, pottery	Solder makers
Gold refiners	Stereotypers
Insecticide makers	Stibnite miners
Insulators, wire	Textile dryers
Lake color makers	Textile flame-retardant workers
Lead burners	Textile printers
Lead hardeners	Type metal workers
Lead shot workers	Typesetters
Linotypers	Vulcanizers
Match makers	Zinc refiners

Adapted from reference 226

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