

VII. APPENDIX I

AIR SAMPLING PRACTICES FOR ARSENIC

General Requirements

In order to evaluate conformance with the standard, 15-minute breathing zone samples representative of the individual worker's exposure shall be collected. Sampling data sheets shall include:

- (a) The date and time of sample collection
- (b) Sampling duration
- (c) Volumetric flowrate of sampling
- (d) A description of the sampling location
- (e) Other pertinent information

Air Sampling

(a) Fifteen-minute breathing zone samples representative of worker exposure shall be collected to characterize the exposure from each job or specific operation in each production area.

(b) Samples shall be collected using a portable sampling pump plus a cellulose membrane filter with a pore size of 5.0 μm or less mounted with backup pad in a 2- or 3-piece closed face cassette.

(c) The sampler shall be operated at a flowrate of 2 liters/min and samples taken for 15 minutes.

(d) A minimum of 3 samples shall be taken for each operation or process.

(e) For 20 or fewer samples, 3 blank filters carried in closed cassettes to the sampling site shall be provided to the analytical laboratory for determination of the background correction which must be applied to the analytical results. One additional blank shall be provided for each 10 samples after the first 20.

Calibration of Sampling Trains

Since the accuracy of an analysis can be no greater than the accuracy of the volume of air which is measured, the accurate calibration of a sampling pump is essential for the correct interpretation of the volume indicated. The frequency of calibration is dependent on the use, care, and handling to which the pump is subjected. In addition, pumps should be recalibrated if they have been subjected to misuse or if they have just been repaired or received from a manufacturer. If the pump receives hard usage, more frequent calibration may be necessary.

Ordinarily, pumps should be calibrated in the laboratory both before they are used in the field and after they have been used to collect a large number of field samples. The accuracy of calibration is dependent on the type of instrument used as a reference. The choice of calibration instrument will depend largely upon where the calibration is to be performed. For laboratory testing, a 1- or 2-liter buret or wet test meter is recommended, although other standard calibrating instruments such as spirometer, Marriott's bottle, or dry-gas meter can be used.

Instructions for calibration with the soapbubble meter follow. If another calibration device is selected, equivalent procedures should be used. The calibration setup for personal sampling pumps with a cellulose

membrane filter is shown in Figure X-1. Since the flowrate given by a pump is dependent on the pressure drop of the sampling device, in this case a membrane filter, the pump must be calibrated while operating with a representative filter and backup pad in line.

(1) While the pump is running, the voltage of the pump battery is checked with a voltmeter to assure adequate voltage for calibration. The battery is charged if necessary.

(2) Place the cellulose membrane filter with backup pad in the filter cassette.

(3) The sampling train is assembled as shown in Figure X-1.

(4) The pump is turned on and the inside of the soapbubble meter is moistened by immersing the buret in the soap solution and drawing bubbles up the inside until they are able to travel the entire buret length without bursting.

(5) The pump rotameter is adjusted to provide a flowrate of 2.0 liters/min.

(6) The water manometer is checked to insure that the pressure drop across the sampling train does not exceed 13 inches of water at 2 liters/min.

(7) A soapbubble is started up the buret and the time it takes the bubble to transit a minimum of 1.0 liter is measured with a stopwatch.

(8) The procedure in (7) above is repeated at least 3 times, the results averaged, and the flowrate calculated by dividing the volume between the preselected marks by the time required for the soapbubble to traverse the distance.

(9) Data for the calibration include the volume measured, elapsed time, pressure drop, air temperature, atmospheric pressure, serial number of the pump, date, and name of the person performing the calibration.

VIII. APPENDIX II
ANALYTICAL METHOD FOR
ARSENIC IN URINE AND AIR

PRINCIPLE OF METHOD

Samples are ashed with a mixture of nitric, perchloric, and sulfuric acids to destroy the organic matrix, and taken to fumes of sulfur trioxide to ensure that all traces of nitric acid are removed. The sample is transferred to an arsine generator where the arsenic is converted to the trivalent form. The arsine is generated from the sample either by the addition of metallic zinc or by the addition of sodium borohydride. The arsine is flushed through the burner of an atomic absorption spectrophotometer for the determination of arsenic content.

RANGE AND SENSITIVITY

For a 25-ml urine sample, the range extends from 0.001 to 0.040 mg As/liter. The range can be extended by taking smaller (or larger) aliquots for analysis. For a 30-liter air sample, the range extends from 0.001 to 0.060 mg As/cu m. Fernandez [86] reported an absolute sensitivity of 0.005 μg (5.0 ng) of arsenic using sodium borohydride reduction, a balloon collection technique, and an electrodeless discharge arsenic lamp.

INTERFERENCES

Organic arsenic compounds would cause a positive interference. Appropriate background correction techniques must be applied in order to

eliminate nonspecific absorption at 1937 Å.

PRECISION AND ACCURACY

At the 95% confidence level, the precision of the atomic absorption method using a continuous flow system is 9% for 1.0 µg As/sample, and is 25% for 0.10 µg As/sample. NIOSH calculated these values from 15 data points, each obtained over several independent runs. The precision of the present balloon technique may be different.

Fernandez [86] reported a coefficient of variation of 3.2% for 0.25 µg As/sample using the balloon collection method. However, the coefficient of variation at the recommended standard (0.060 µg or 60.0 ng As/sample) is expected to be greater.

The accuracy of the method has not been determined at this time.

ADVANTAGES AND DISADVANTAGES OF THE METHOD

This method has the advantage of being free of interference by antimony. It is somewhat faster, and several times as sensitive as the colorimetric method for arsenic. The disadvantages include the requirement of specialized equipment and the use of rather large volumes of expensive gases. This analytical procedure does not distinguish between pentavalent and trivalent arsenic compounds. Specialized research methods which are not widely used reportedly can distinguish between these valence states. [110,111]

APPARATUS

- (a) Atomic absorption spectrophotometer equipped with arsine generator, deuterium arc background correction, and argon-hydrogen system. (Figure X-2) An electrodeless discharge arsenic lamp is recommended.
- (b) 125-ml borosilicate Phillips beakers.
- (c) Hood facilities capable of handling perchloric acid fumes.
- (d) Specific gravity meter or hydrometer capable of measuring specific gravities in the range of 1.000-1.040 \pm 0.001.
- (e) 25-ml borosilicate volumetric flasks.

REAGENTS AND GASES

All chemicals must be ACS reagent grade or better. Double deionized water or equivalent must be used.

- (a) Nitric acid, distilled reagent grade.
- (b) Perchloric acid, 72%.
- (c) Sulfuric acid, 90%.
- (d) Hydrochloric acid, 36%.
- (e) Potassium iodide solution. Dissolve 20 g of potassium iodide in 100 ml double distilled water.
- (f) Stannous chloride solution. Dissolve 20 g of stannous chloride dihydrate in 100 ml of concentrated hydrochloric acid.
- (g) Zinc, 20 mesh granular, low arsenic.
- (h) Sodium borohydride, 11/32-inch pellets.
- (i) Arsenic standard stock solution, 1,000 ppm. Dissolve 1.320 g of arsenic trioxide in 10 ml of 40% sodium hydroxide and dilute to 1 liter with distilled water. Commercially prepared stock solutions are also

available. Working standards are made by diluting the stock solution.

(j) Gases. Hydrogen, electrolytic grade. Argon, high purity.

PROCEDURE

(a) Cleaning Equipment

All glassware must be cleaned with a detergent solution followed by both tap water and distilled water rinses. Then the glassware is cleaned with hot concentrated nitric acid and thoroughly rinsed with tap water followed by distilled water. (Arsine generators are rinsed with concentrated hydrochloric acid following the nitric acid wash.)

(b) Collection of Urine Samples

Urine samples are collected in polyethylene bottles which are precleaned in nitric acid. About 0.1 g EDTA is added as a preservative. At least 75 ml of urine should be collected. Care should be taken to prevent leaking of bottles in transit.

(c) Collection of Air Samples

Air samples are collected in accordance with Appendix I.

ANALYSIS OF SAMPLES

Determine the specific gravity of the urine sample at room temperature. This may be done with the use of a specific gravity meter or a reliable hydrometer.

Transfer 25 ml of the urine sample, or the membrane filter for air samples, into a 125-ml Phillips beaker. Wet-ash the sample by treating with 5 ml of a mixture of 3 parts nitric acid, 1 part sulfuric acid, and 1

part perchloric acid and heating on a hot plate at 130-150 C. Keep adding small amounts of redistilled nitric acid until a colorless (liquid) ash is obtained. If the ashing is still incomplete, additional perchloric acid can be added dropwise. Continue heating to fumes of sulfur trioxide.

Allow the mixture to cool, then transfer to a 25-ml volumetric flask and make up to volume with distilled water. For urine samples, pipet a 5-ml aliquot of the 25-ml sample into an arsine generation flask with balloon attached. For air samples, transfer the entire sample to the arsine generation flask. The arsine can be generated by either of the following 2 methods.

(a) Reduction with zinc. Add in order 15 ml of distilled water, 10 ml of concentrated hydrochloric acid, 2 ml of potassium iodide solution, and 2 ml of stannous chloride solution. (Swirl solution after the addition of each reagent for homogeneous mixing.) Mix well and allow to stand for 15 minutes to insure the conversion of arsenic to the trivalent form. Attach the flask to the generating system and open the 4-way stopcock for 15 seconds to flush the air out of the system with argon. Add 1.5 g of zinc to the sample solution via the addition stopcock.

(b) Reduction with sodium borohydride. Add 35 ml of distilled water, 5 ml concentrated hydrochloric acid, and mix well. Connect the sample flask to the generating system and open the 4-way stopcock for 15 seconds to flush air out of the system with argon. Add to the sample solution, via the addition stopcock, a single sodium borohydride pellet (11/32-inch diameter, 200-mg).

The reaction is vigorous and the balloon fills with the evolved gases thus acting as a reservoir for the generating system. After one minute,

open the 4-way stopcock allowing the pressure in the balloon to flush the gases into the flame of the atomic absorption instrument. The absorbance is recorded on a rapid response strip chart recorder. Larger (or smaller) aliquots of the sample solution may be taken if the signal is not in the proper range.

CALIBRATION AND STANDARDS

Prepare working standards of 0.25, 0.50, 1.0, 3.0, 5.0, and 7.0 μg of arsenic in 25 milliliters of solution by dilution of the standard stock solution. These standards should be prepared fresh each time.

Construct a calibration curve by pipetting 5 ml of each of the working standards into arsine generators and proceeding with the analysis. A calibration curve of absorbance versus micrograms of arsenic is plotted and used for the determination of arsenic content of the samples.

CALCULATIONS

(a) Urine Samples

The concentration of arsenic in the urine sample can be expressed as mg As/liter of urine.

$$\text{mg As/liter} = \frac{\mu\text{g As}}{\text{ml of urine}} \quad (\text{from calibration curve})$$

The use of a specific gravity correction factor to normalize values to 1.024, the average specific gravity of urine, has been proposed. [92-94,96] The following correction is recommended. Specific gravities less

than 1.010 are unreliable and these samples should be discarded.

$$\text{corrected mg As/liter} = \text{mg As/liter} \times \frac{(1.024-1.000)}{(\text{specific gravity} - 1.000)}$$

(b) Air Samples

The concentration of arsenic in air can be expressed as milligrams As per cubic meter of air, which is numerically equal to micrograms As per liter of air.

$$\text{mg As/cu m} = \mu\text{g As/V}$$

where:

$\mu\text{g As}$ = micrograms As from calibration curve

V = volume of air sampled (in liters) at 25 C and 760 mmHg.

IX. APPENDIX III
MATERIAL SAFETY DATA SHEET

The following items of information which are applicable to a specific product or material shall be provided in the appropriate block of the Material Safety Data Sheet (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 in as large type size 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 rules 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 number (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, ie, "100 ppm LC50-oral-rat," "25 mg/cu m LD50-skin-rabbit," "75 ppm LC man," or "permissible exposure from 29 CFR 1910.93," 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. Flammable or reactive data

could be flash point, shock sensitivity, or other brief data indicating nature of the hazard.

(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 (indicated if by weight or volume) at 70 degrees Fahrenheit (21.1 degrees Celsius); 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 flash point and autoignition temperature in degrees Fahrenheit (Celsius in parentheses); flammable limits, in percent by volume in air; suitable extinguishing media or materials; special fire fighting 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 time-weighted average (TWA) concentration, as a permissible exposure, or by some other indication of an acceptable standard. 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, mild irritation and possibly some blistering.

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 anti-pollution ordinances" are proper but not sufficient. Specific procedures shall 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. Respirators shall be specified as to type and NIOSH or US Bureau of Mines 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) Undersigning 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 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: _____

TABLE X-1

PHYSICAL AND CHEMICAL PROPERTIES OF
IMPORTANT INORGANIC ARSENICALS

Arsenic, As

Physical state: gray metal, hexagonal-rhombic crystals
also yellow cubic crystals (As₄)
Atomic weight: 74.9216
Specific gravity: 5.727
Melting point: sublimes at 613 C
Solubility: insoluble in water

Arsenic Trichloride, AsCl₃

Physical state: oily liquid or needle shaped crystals
Formula weight: 181.28
Specific gravity: 2.163 (20 C)
Melting point: -8.5 C
Boiling point: 130.2 C
Vapor density: 6.25 (air = 1)
Vapor pressure: 10 mmHg (23.5 C)
Solubility: decomposes in water
Percent arsenic: 41

Arsenic Trioxide, As₂O₃ (White Arsenic, Arsenous Oxide)

Physical state: transparent crystals or amorphous white powder
Formula weight: 197.84
Specific gravity: 3.738
Melting point: 315 C
Solubility, in g/100cc water: 3.7 at 20 C, 10.14 at 100 C
Percent arsenic: 76

Arsenic Pentoxide, As₂O₅ (Anhydride of Arsenic Acid)

Physical state: deliquescent, white amorphous powder
Formula weight: 229.84
Specific gravity: 4.32
Melting point: decomposes at 315 C
Solubility, in g/100cc water: 150 at 16 C, 76.7 at 100 C
Percent arsenic: 65

Arsine, AsH₃

(Arsenic Hydride, Arseniuretted Hydrogen)
Physical state: colorless gas
Formula weight: 77.95
Density: 2.695
Boiling point: -55 C
Percent arsenic: 96

TABLE X-1 (CONTINUED)

Calcium Arsenate, $\text{Ca}_3(\text{AsO}_4)_2$

Physical state: colorless amorphous powder
 Formula weight: 398.08
 Specific gravity: 3.62
 Melting point: 1455
 Solubility, in g/100cc water: 0.013 at 25 C
 Percent arsenic: 38; also occurs with 3 moles of water,
 in which case the molecular weight is 452.11, and the percent
 arsenic is 33.

Cupric Arsenite, CuHAsO_3 (approx) (Scheele's Green, Swedish Green)

Physical state: yellowish green powder
 Formula weight: 187.47
 Melting point: decomposes
 Solubility: insoluble in water
 Percent arsenic: 40

Lead Arsenate, $\text{Pb}_3(\text{AsO}_4)_2$ (Lead Orthoarsenate)

Physical state: white crystals
 Formula weight: 899.41
 Melting point: 1042 C, slightly decomposes at 1000 C
 Solubility: very slightly soluble in cold water
 Specific gravity: 7.8
 Percent arsenic: 17

Lead Arsenite, $\text{Pb}(\text{AsO}_2)_2$ (Lead Metarsenite)

Physical state: white powder
 Formula weight: 421.03
 Specific gravity: 5.85
 Solubility: insoluble in cold water
 Percent arsenic: 36

Ortho-Arsenic Acid, $\text{H}_3\text{AsO}_4 \cdot 1/2\text{H}_2\text{O}$

Physical state: white translucent hygroscopic crystals
 Formula weight: 150.95
 Specific gravity: 2.0 to 2.5
 Melting point: 35.5 C
 Boiling point: 160 C
 Solubility, in g/100cc: 16.7 in cold water
 50 in hot water
 Percent arsenic: 50

Sodium Arsenite, NaAsO_2 (Sodium Metarsenite)

Physical state: gray-white powder
 Formula weight: 129.91
 Specific gravity: 1.87
 Solubility: very soluble in water
 Percent arsenic: 58

from Patty [5] and Weast and Selby [7]

TABLE X-2
OCCUPATIONS WITH POTENTIAL ARSENIC EXPOSURE

acetylene workers	insecticide makers
acid dippers	jewelers
alloy makers	lead burners
aniline color makers	lead shot makers
aniline workers	lead smelters
arsine workers	leather workers
Babbitt metal workers	lime burners
bleaching powder makers	metal cleaners
boiler operators	metal refiners
brass makers	nitrocellulose makers
bronze makers	ore smelter workers
bronzers	organic chemical synthesizers
cadmium workers	paint makers
cattle dip workers	painters
ceramic enamel makers	paper makers
ceramic makers	petroleum refinery workers
copper smelters	pigment makers
defoliant applicators	plastic workers
defoliant makers	plumbers
dimethyl sulfate makers	printing ink workers
drug makers	rayon makers
dye makers	rodenticide makers
electrolytic copper makers	semiconductor compound makers
electroplaters	sheep dip workers
enamellers	silver refiners
etchers	soda makers
farmers	solderers
ferrosilicon workers	submarine workers
fertilizer makers	sulfuric acid workers
fireworks makers	taxidermists
galvanizers	textile printers
glass makers	tinners
gold extractors	tree sprayers
gold refiners	type metal workers
hair remover makers	water weed controllers
herbicide makers	weed sprayers
hide preservers	wood preservative makers
hydrochloric acid workers	wood preservers
illuminating gas workers	zinc chloride makers

from Gafafer [9]

TABLE X-3
 1965 SMELTER SURVEY
 ATMOSPHERIC ARSENIC CONCENTRATIONS (mg As/cu m)

"Heavy exposure area" as classified by Lee and Fraumeni [49]

<u>Arsenic Roaster Area</u>		Mean: 1.47
0.10	0.20	Median: 0.185
0.10	0.22	
0.10	0.25	
0.10	0.35	
0.10	1.18	
0.10	5.00	
0.17	12.66	

"Medium exposure areas" as classified by Lee and Fraumeni [49]

<u>Reverberatory Area</u>		Mean: 1.56
0.03	0.93	Median: 0.88
0.22	1.00	
0.23	1.27	
0.36	1.60	
0.56	1.66	
0.63	1.84	
0.66	1.94	
0.76	2.06	
0.78	2.76	
0.78	3.40	
0.80	4.14	
0.83	8.20	

<u>Treater Building and Arsenic Loading</u>		Mean: 1.50
0.10	0.48	Median: 0.295
0.10	0.62	
0.10	3.26	
0.11	7.20	

"Light exposure areas" as classified by Lee and Fraumeni [49]

<u>Copper Concentrate Transfer System</u>		Mean: 0.70
0.25		Median: 0.65
0.65		
1.20		

<u>Samples from Flue Station</u>		Mean: 0.17
0.10		Median: 0.17
0.24		

<u>Reactor Building</u>		Mean: 0.004
0.001	0.003	Median: 0.002
0.002	0.009	
0.002	0.010	
0.002		

TABLE X-4
 1965 SMELTER SURVEY
 URINARY ARSENIC

<u>Job Title</u>	<u>mg As/liter of urine</u>
Rapper	0.06
Stack foreman	0.15
Station man	0.36
Station man	0.46
Scraper operator	0.19
Scraper operator	0.47
Treaterman	0.24
Louvre man (treater)	0.11
Louvre man (treater)	0.12
Dump floorman	0.40
Dump floorman (main flue)	0.17
Furnace operator	0.15
Furnaceman	0.17
Repairman	0.48
Change floor operator	0.32
Cleaner	0.27
Funnel loader	0.43
Arsenic roaster foreman	0.17
Arsenic loader	0.04
Arsenic loader	0.06
Arsenic loader	0.14
Arsenic loader	0.19
Arsenic loader	0.29
	Mean 0.24
	Median 0.17

FIGURE X - 1. CALIBRATION SETUP FOR PERSONAL SAMPLING PUMP WITH FILTER CASSETTE

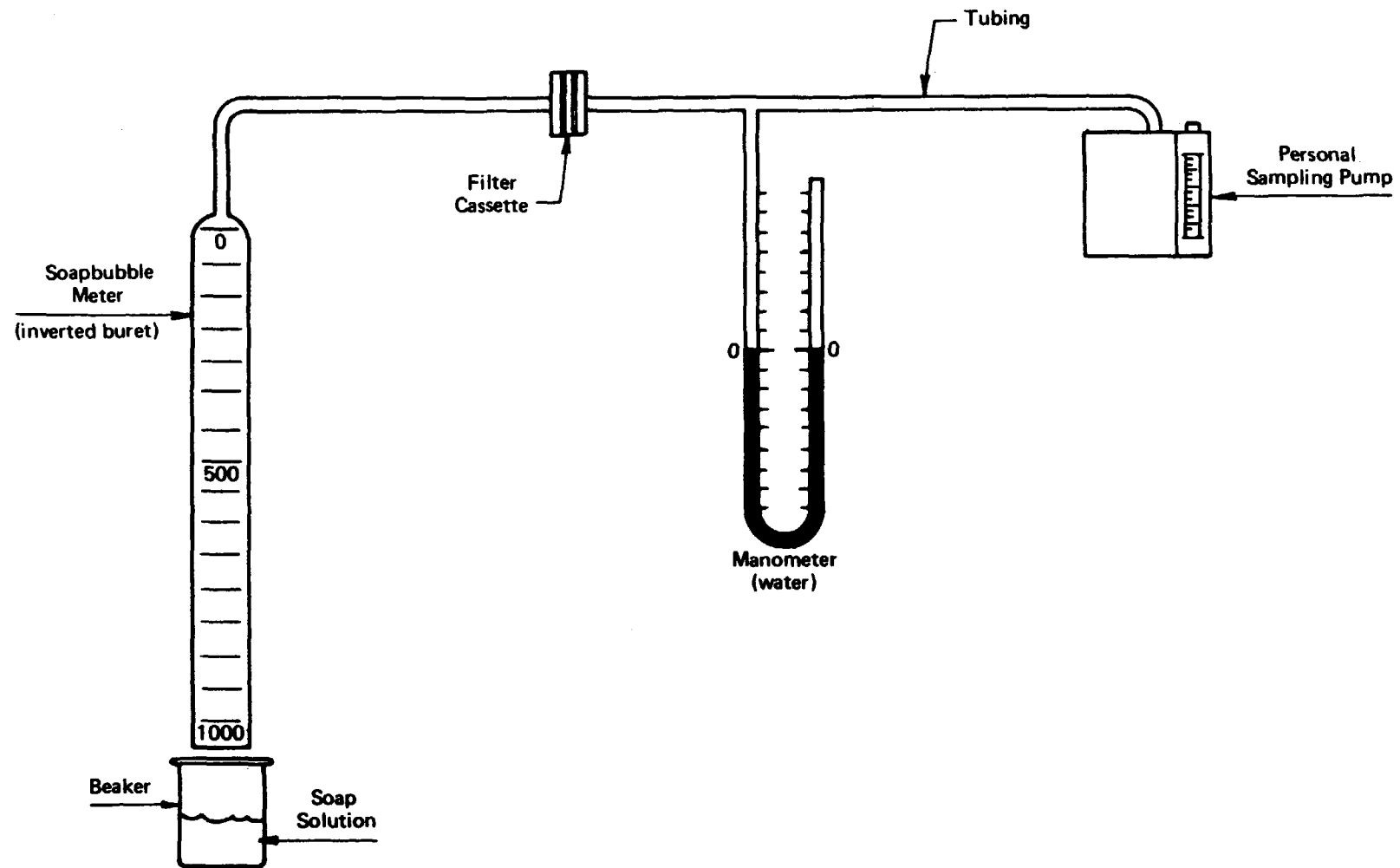
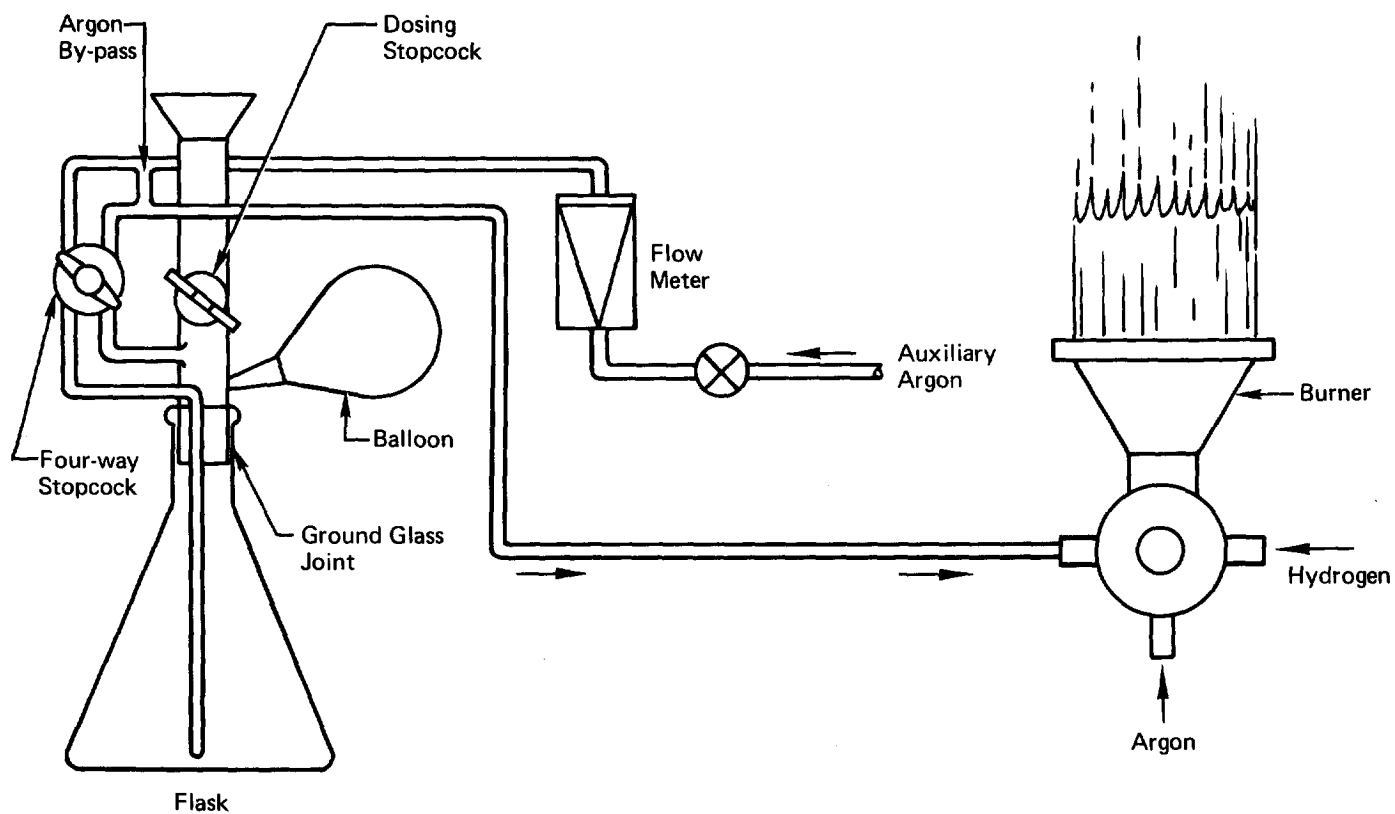


FIGURE X - 2. APPARATUS FOR ARSINE GENERATION



Instrument conditions to use for arsine measurement by atomic absorption.

wavelength - 1937 \AA
 slit - 7 \AA
 burner - three slot
 Argon Flow - 8 scfh
 H_2 Flow - 3 scfh
 Recorder - fast response
 Aspirate water continuously during analysis.

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