

IX. APPENDIX I

SAMPLING PRACTICES FOR BERYLLIUM

Air Sampling

The measurement of general air concentrations shall be included with worker breathing zone samplings and shall meet the following criteria in order to evaluate conformance with the standard:

(a) Samples collected shall measure accurately the individual worker's exposure.

(b) Samples shall include all beryllium particles, both respirable and non-respirable, in the volume of air sampled. The standard is based upon total beryllium content, and it is inappropriate to sample only respirable dust. The attempt to apply the results of respirable sampling to the present recommended standard of 2 ug Be/m^3 potentially eases the standard as much as five to ten times depending on the percentage of respirable dust present in any given air sample determination.

(c) Sampling procedures shall include a log of:

(1) The time of sample collection, (2) sampling duration, (3) volume rate of the sampler, and (4) a description of the sampling location and pertinent circumstances.

(d) General air and breathing-zone samples shall be collected with samplers having an air capacity not less than 0.05 m^3 per minute and equipped with Whatman No. 41 filters or equivalent.

General Room-Air Sampling

(a) A minimum of 3 general air measurements shall be made in each location during a work period and averaged.

(b) General air sampling periods shall be from a minimum of 30 minutes

to no more than two hours.

(c) Non-working areas (eating, smoking, locker, etc.) shall be sampled during periods of representative activity.

Breathing Zone Sampling

(a) Breathing-zone samples shall be collected as near as practicable to the worker's face without interfering with his freedom of movement and shall characterize the exposure from each job or specific operation in each production area.

(b) A minimum of three breathing-zone samples shall be taken for each operation (four or five samples are recommended) and averaged on a time-weighted basis.

(c) Breathing-zone sampling periods shall be for a minimum of 3 minutes.

Evaluation of Exposure

(a) On the basis of results from the environmental samples a time-weighted average concentration shall be completed for each work area and properly logged and maintained on file for review. A job analysis format as presented by Breslin⁷ is shown in Figure 1.

(b) Exposure evaluations shall be performed at least quarterly for each work area where potential exposure to beryllium could occur.

Calibration of Sampling Equipment

Air samplers shall be calibrated prior to each use by a typical system as shown in Figure 2. A calibration curve is established by obtaining at least ten evenly spaced flow rates over the entire operating range of the air sampler. The motor speeds of the air blower and air sampler should be varied concurrently to set the rotameter at a given air-flow rate while maintaining atmospheric conditions at the upstream face of the filter. For

each rotameter air flow rate, either the corresponding air-flow rate on the sampler or the static pressure-drop across the filter is used. The measurements are repeated for each filter at the same air-flow rates and at least ten filters shall be tested to establish each initial calibration curve. For future calibration checks, fewer filters may be tested as long as they are within the limits of the ten initial filters.

X. APPENDIX II
ANALYTICAL METHOD FOR BERYLLIUM
ATOMIC ABSORPTION METHOD

Use of an atomic absorption spectrophotometer provides perhaps the most economical method for the analysis of beryllium. This method is recommended by NIOSH for purposes of determining compliance with the recommended beryllium standard. Other methods of analysis for beryllium may be used provided their accuracy and sensitivity are determined to be equivalent to the method presented herein.

Principle of the Method

The liquid sample containing the beryllium is aspirated into the flame of the burner-assembly and the vaporized sample is irradiated by a lamp containing a cathode made of beryllium metal. The ground-state atoms of beryllium in the sample absorb the 2348.6A resonance line of beryllium emitted by this lamp, thereby effecting a decrease in the intensity of light reaching a photodetector. The percent of the absorption so indicated is a measure of the concentration of beryllium in the sample.

Range and Sensitivity

For aqueous solutions, the working range for beryllium is linear from concentrations of 0.03 $\mu\text{g/ml}$ to approximately 4 $\mu\text{g/ml}$.¹¹⁷ The sensitivity under the standard operating conditions is about 0.03 $\mu\text{g/ml}$ beryllium for 1 percent absorption.¹¹⁷ This sensitivity can be increased with chemical concentration by solvent extraction.

Interferences

High concentrations of aluminum (500 µg/ml) depress the sensitivity of the beryllium determination. High concentrations of silicon and magnesium also decrease the sensitivity. The interference can be controlled by adding oxine (8-hydroxy-quinoline) to the sample and standards.¹¹⁷

Precision and Accuracy

The standard procedure for beryllium will provide a coefficient of variation of about 0.5 to 2 percent depending upon the instrument used and the absorbance of the samples.¹¹⁷

Apparatus

(a) Atomic absorption spectrophotometer, having a monochromator with a reciprocal linear dispersion in the ultraviolet region of about 6.5 Å/mm. The instrument should have a sensitivity sufficient to provide a calibration curve usable from 0.2 to 8 ppm with the 2348.6Å beryllium line.

(b) Beryllium hollow cathode lamp of high spectral purity and adequate sensitivity.

(c) Acetylene gas in a cylinder equipped with a two-gauge, two-stage pressure-reducing regulator and hose connections.

(d) Nitrous oxide in a cylinder equipped with a two-gauge, two-stage pressure-reducing regulator and hose connections. Heat-tape, with the temperature controlled by a rheostat, is wound around the second stage regulator and connecting hose to prevent freeze-up of the line.

Reagents

All reagents are analytical reagent-grade. Nitric and hydrochloric acids are redistilled. All solutions are prepared from deionized water.

(a) Stock beryllium solution. A solution containing 1000 μg of beryllium per milliliter is prepared by dissolving 1.000 gm of beryllium metal in a minimum volume of 1:1 HCl. Dilute to 1 liter with 1% (V/V) HCl.

(b) Beryllium standard solution. Prepared by making appropriate dilutions from the stock beryllium solution and acidifying with 1 ml of redistilled HCl for each 10 ml of solution. Thus prepared, a standard solution is stable for at least several months.

Procedure

Borosilicate glassware is recommended for this method. Glassware is soaked in a mild detergent solution immediately after use to remove any residual grease or chemicals and thus to prevent the formation of an adsorptive surface. Before use, each piece is cleaned with a saturated solution of sodium dichromate in concentrated sulfuric acid and then rinsed thoroughly in succession with warm tap water, concentrated nitric acid, tap water, and finally deionized water.

(a) Sample Preparation

Air Samples--The entire filter or impinger sample is transferred to a 125 ml Phillips beaker and ashed with nitric acid. If a fiberglass filter was used for sampling, it is necessary to first destroy the filter with hydrofluoric acid in a platinum or teflon dish prior to ashing with nitric acid in the Phillips beaker. When ashing is complete, convert

the residue to the chloride form. The residue is then dissolved in a minimal amount of hydrochloric acid and water and evaporated in an oven to a volume of 2.0 ml or more depending on the amount of beryllium expected in the sample.

(b) Determination of Beryllium

The HCl solution of the ashed or fused sample is aspirated directly into the nitrous oxide-acetylene flame. A special nitrous oxide-acetylene burner head must be used. The 2348.6A resonance line of beryllium is used. The operating parameters vary according to the make of instrument being employed. Consult the instrument manufacturer's instructions for the particular instrument settings and procedure for lighting the nitrous oxide-acetylene flame. A reducing, fuel-rich flame, is needed for the desired sensitivity in the beryllium analysis.

If the beryllium concentration falls between 0.2 and 8.0 $\mu\text{g/ml}$, the percent of absorption values of the samples are recorded on the 1X scale or the absorbance or concentration values are read directly if these features are available on the instrument being employed. If the beryllium concentration is between 0 and 0.2 $\mu\text{g/ml}$, scale expansion can be used, if available; however, longer aspiration time is needed when using scale expansion since higher noise suppression is required. The percent of absorption of each sample run on the 1X scale is determined from the recorder chart and this value is converted to absorbance. The concentration of beryllium in each sample is determined by referring to the standard curve where beryllium concentration is plotted versus absorbance. If the samples were recorded on an expanded scale, the percent of absorption

value is related directly to concentration since the standard curve is plotted similarly. If absorbance values are read directly from the instrument, a standard curve is prepared plotting the absorbance versus concentration.

Standardization

Beryllium standards are prepared by appropriate dilutions of the stock solution. Each standard solution contains 1 ml of 1:1 redistilled HCl per 10 ml of solution. The standards are aspirated into the flame and the percent of absorption is recorded or the absorbance is read for each concentration. A standard curve is prepared for the two concentrations; ranges of 0 to 8 µg/ml and 0 to 0.5 µg/ml. If high concentrations of aluminum, silicon, or magnesium are present in the samples, the standards should be prepared in a similar base.

Calculations

The percent of absorption is converted to absorbance. The standard curve is used to get a beryllium concentration value in terms of µg/ml for the absorbance value. This µg Be/ml value is multiplied by the sample aliquot to determine the total beryllium in the sample.

Calculation of Beryllium Concentration

$$\frac{\text{Total } \mu\text{g Be}}{\text{m}^3 \text{ of air sample}} = \mu\text{g Be/m}^3 \text{ of ambient air}$$

Effect of Storage

Samples and standards can be stored indefinitely without loss of beryllium as long as the pH of solutions is maintained at less than 2.

XI. APPENDIX III

MATERIAL SAFETY DATA SHEET

The following items of information which are applicable to a specific product or material containing beryllium shall be provided in the appropriate section of the Material Safety Data Sheet or approved form. If a specific item of information is inapplicable (i.e., flash point) initials "n.a." for not applicable shall be inserted.

(a) The product designation in the upper left hand corner of both front and back to facilitate filing and retrieval. Print in upper case letters in as large print as possible.

(b) Section I. Source and Nomenclature.

(i) The name, address, and telephone number of the manufacturer or supplier of the product.

(ii) The trade name and synonyms for a mixture of chemicals, a basic structural material, or for a process material; and the trade name and synonyms, chemical name and synonyms, chemical family, and formula for a single chemical.

(c) Section II. Hazardous Ingredients

(i) Chemical or widely recognized common name of all hazardous ingredients.

(ii) 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 of maximum amount; i.e., 10-20% V; 10% max. W.

(iii) Basis for toxicity for each hazardous material such as established OSHA standard (TLV), in appropriate units and/or LD₅₀, showing

amount and mode of exposure and species, or LC₅₀ showing concentration and species.

(d) Section III. Physical Data.

Physical properties of the total product including boiling point and melting point in degrees Fahrenheit; vapor pressure, in millimeters of mercury, vapor density of gas or vapor (air=1), solubility in water, in parts per hundred parts of water by weight; specific gravity (water=1); percent volatile, indicate if by weight or volume, at 70 degrees Fahrenheit; evaporation rate for liquids (indicate whether butyl acetate or ether=1); and appearance and odor.

(e) Section IV. Fire and Explosion Hazard Data.

Fire and explosion hazard data about a single chemical or a mixture of chemicals, including flash point, in degrees Fahrenheit; flammable limits, in percent by volume in air; suitable extinguishing media or agents; special fire fighting procedures; and unusual fire and explosion hazard information.

(f) Section V. Health Hazard Data.

Toxic level for total compound or mixture, relevant symptoms of exposure, skin and eye irritation properties, principal routes of absorption, effects of chronic (long-term) exposure, and emergency and first aid procedures.

(g) Section VI. Reactivity Data.

Chemical stability, incompatibility, hazardous decomposition products, and hazardous polymerization.

(h) Section VII. Spill or Lead Procedures.

Detailed procedures to be followed with emphasis on precautions

to be taken in cleaning up and safe disposal of materials leaked or spilled. This includes proper labeling and disposal of containers containing residues, contaminated absorbants, etc.

(i) Section VIII. Special Protection Information.

Requirements for personal protective equipment, such as respirators, eye protection and protective clothing, and ventilation such as local exhaust (at site of product use or application), general, or other special types.

(j) Section IX. Special Precautions.

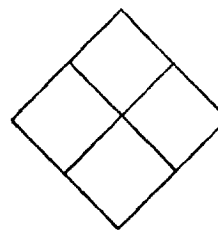
Any other general precautionary information such as personal protective equipment for exposure to the thermal decomposition products listed in Section VI, and to particulates formed by abrading a dry coating, such as by a power sanding disc.

(k) The signature of the responsible person filling out the data sheet, his address, and the date on which it is filled out.

PRODUCT DESIGNATION

MATERIAL SAFETY
DATA SHEET

Form Approved
Budget Bureau No.
Approval Expires
Form No. OSHA



SECTION I SOURCE AND NOMENCLATURE

MANUFACTURER'S NAME	EMERGENCY TELEPHONE NO.
ADDRESS (Number, Street, City, State, ZIP Code)	
TRADE NAME AND SYNONYMS	CHEMICAL FAMILY
CHEMICAL NAME AND SYNONYMS	FORMULA

SECTION II HAZARDOUS INGREDIENTS

BASIC MATERIAL	APPROXIMATE OR MAXIMUM % WT. OR VOL.	ESTABLISHED OSHA STANDARD	LD ₅₀		LC ₅₀	
			ORAL	PERCUT.	SPECIES	CONC.

SECTION III PHYSICAL DATA

BOILING POINT	°F.	VAPOR PRESSURE	mm Hg.
MELTING POINT	°F.	VAPOR DENSITY (Air=1)	
SPECIFIC GRAVITY (H ₂ O=1)		EVAPORATION RATE (_____ =1)	
SOLUBILITY IN WATER	Pts/100 pts H ₂ O	VOLATILE	% Vol. % Wt.
APPEARANCE AND ODOR			

SECTION IV FIRE AND EXPLOSION HAZARD DATA

FLASH POINT	FLAMMABLE (EXPLOSIVE) LIMITS	UPPER
METHOD USED		LOWER
EXTINGUISHING MEDIA		
SPECIAL FIRE FIGHTING PROCEDURES		
UNUSUAL FIRE AND EXPLOSION HAZARDS	XI-4	

PRODUCT
DESIGNATION

SECTION V HEALTH HAZARD DATA

TOXIC
LEVEL

CARCINOGENIC

PRINCIPLE ROUTES
OF ABSORPTION

SKIN AND EYE
IRRITATION

RELEVANT SYMPTOMS
OF EXPOSURE

EFFECTS OF
CHRONIC EXPOSURE

EMERGENCY AND
FIRST AID
PROCEDURES

SECTION VI REACTIVITY DATA

CONDITIONS CONTRIBUTING
TO INSTABILITY

CONDITIONS CONTRIBUTING
TO HAZARDOUS POLYMERIZATION

INCOMPATIBILITY
(Materials to Avoid)

HAZARDOUS DECOMPOSITION
PRODUCTS

SECTION VII SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN
CASE MATERIAL IS
RELEASED OR SPILLED

WASTE DISPOSAL
METHOD

SECTION VIII SPECIAL PROTECTION INFORMATION

VENTILATION REQUIREMENTS
LOCAL EXHAUST

PROTECTIVE EQUIPMENT (Specify Types)
EYE

MECHANICAL (General)

GLOVES

SPECIAL

RESPIRATOR

OTHER PROTECTIVE
EQUIPMENT

SECTION IX SPECIAL PRECAUTIONS

PRECAUTIONS TO BE
TAKEN IN HANDLING
AND STORAGE

OTHER PRECAUTIONS

Signature _____

Address _____

Date _____