

# OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR BARIUM SULFATE

## INTRODUCTION

This guideline summarizes pertinent information about barium sulfate for workers and employers as well as for physicians, industrial hygienists, and other occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments; readers are therefore advised to regard these recommendations as general guidelines and to determine periodically whether new information is available.

## SUBSTANCE IDENTIFICATION

### • Formula



### • Synonyms

Actybaryte; artificial barite; artificial heavy spar; bakontal; baridol; barite; barospere; barotrast; baryta white; barytes; bayrites; citobaryum; colonatrast; finemeal; liquibarine; macropaque; neobar; oratrast; permanent white; precipitated barium sulphate; raybar; redi-flow; solbar; sulfuric acid, barium salt (1:1); supramike; travad; unibaryt

### • Identifiers

1. CAS No.: 7727-43-7
2. RTECS No.: CR0600000
3. DOT UN: None
4. DOT label: None

### • Appearance and odor

Barium sulfate is a heavy, noncombustible, white or yellowish, odorless powder or crystalline solid. It occurs naturally as the mineral barite and can also be manufactured. Barium sulfate is available in several commercial grades, including technical, dry, pulp, bleached, ground, floated, natural, pharmaceutical, and X-ray.

## CHEMICAL AND PHYSICAL PROPERTIES

### • Physical data

1. Molecular weight: 233.42
2. Boiling point (760 mm Hg): Not applicable
3. Specific gravity (water = 1): 4.25 to 4.50 at 20°C (68°F)
4. Vapor density: Not applicable.
5. Melting point: 1,580°C (2,876°F); decomposes above 1,600°C (2,912°F)
6. Vapor pressure at 20°C (68°F): Not applicable
7. Solubility: Almost insoluble in water, dilute acids, or alcohol; soluble in hot concentrated sulfuric acid
8. Evaporation rate: Not applicable

### • Reactivity

1. Conditions contributing to instability: None
2. Incompatibilities: Explosions may result from contact of barium sulfate with aluminum in the presence of heat.
3. Hazardous decomposition products: Toxic gases and particulates (such as sulfur oxides or barium fumes) may be released in a fire involving barium sulfate.
4. Special precautions: None

### • Flammability

The National Fire Protection Association has not assigned a flammability rating to barium sulfate; this substance is not combustible.

1. Flash point: Not applicable
2. Autoignition temperature: Not applicable
3. Flammable limits in air: Not applicable
4. Extinguishant: Use an extinguishant that is suitable for the materials involved in the surrounding fire.

Fires involving barium sulfate should be fought upwind and from the maximum distance possible. Isolate the hazard area and deny access to unnecessary personnel. Emergency personnel should stay out of low areas and ventilate closed spaces before entering. Containers of barium sulfate may

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explode in the heat of the fire and should be moved from the fire area if it is possible to do so safely. If this is not possible, cool containers from the sides with water until well after the fire is out. Stay away from the ends of containers. Personnel should withdraw immediately if they hear a rising sound from a venting safety device or if a container becomes discolored as a result of fire. Dikes should be used to contain fire-control water for later disposal. Do not scatter this material. If a tank car or truck is involved in a fire, personnel should isolate an area of a half mile in all directions. Firefighters should wear a full set of protective clothing (including a self-contained breathing apparatus) when fighting fires involving barium sulfate. Chemical protective clothing that is specifically recommended for barium sulfate may not provide thermal protection unless so stated by the clothing manufacturer. Firefighters' protective clothing may not provide protection against permeation by barium sulfate.

## EXPOSURE LIMITS

### • OSHA PEL

The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for barium sulfate is 10 mg/m<sup>3</sup> of air (total dust) and 5 mg/m<sup>3</sup> (respirable fraction) as 8-hr time-weighted average (TWA) concentrations [29 CFR 1910.1000, Table Z-1-A].

### • NIOSH REL

The National Institute for Occupational Safety and Health (NIOSH) has established a recommended exposure limit (REL) of 10 mg/m<sup>3</sup> of air (total dust) and 5 mg/m<sup>3</sup> (respirable fraction) as 8-hr TWA concentrations [NIOSH 1992].

### • ACGIH TLV<sup>®</sup>

The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned barium sulfate a threshold limit value (TLV) of 10 mg/m<sup>3</sup> (total dust) as a TWA for a normal 8-hr workday and a 40-hr workweek [ACGIH 1991b].

### • Rationale for limits

The limits are based on the risk of eye, nose, and upper respiratory tract irritation and pneumoconiosis associated with exposure to barium sulfate.

## HEALTH HAZARD INFORMATION

### • Routes of exposure

Exposure to barium sulfate can occur through inhalation and eye or skin contact.

## 2 Barium Sulfate

### • Summary of toxicology

1. *Effects on Animals:* Barium sulfate dust is a mechanical irritant. Rats exposed to a 40-mg/m<sup>3</sup> concentration of barium sulfate dust for 5 hr/day during a 2-month period did not show adverse effects [ACGIH 1991a]. In another study, rats inhaling barium sulfate dust (concentration not specified) developed a reversible pneumoconiosis without fibrosis [NLM 1991]. Intratracheal injection of radioactive barium sulfate caused bronchogenic carcinomas in rats [Clayton and Clayton 1981].

2. *Effects on Humans:* Inhalation of barium sulfate causes physical irritation and a benign pneumoconiosis (known as baritosis) in humans. In Italy, Germany, Czechoslovakia, and the United States, workers exposed to the fine dust of barium sulfate have developed a benign, noncollagenous form of pneumoconiosis that generally disappears when exposure ceases. Although chronic bronchial irritation occasionally persists after termination of exposure, no adverse effects on pulmonary function have been reported [Clayton and Clayton 1981; NLM 1991].

### • Signs and symptoms of exposure

1. *Acute exposure:* Acute exposure to barium sulfate can cause redness and itching of the eyes and nose and a scratchy throat. No other acute effects have been reported.

2. *Chronic exposure:* Chronic exposure to barium sulfate can cause radiographic evidence of disseminated, discrete nodular opacities in the lung fields; in most cases, these opacities disappear after cessation of exposure. Chronic bronchial irritation has been reported occasionally in baritotic workers.

### • Emergency procedures



Keep unconscious victims warm and on their sides to avoid choking if vomiting occurs. Initiate the following emergency procedures:

1. *Eye exposure:* Irritation may result! *Immediately and thoroughly* flush the eyes with large amounts of water, occasionally lifting the upper and lower eyelids.

2. *Skin exposure:* Wash contaminated skin with soap and water.

3. *Inhalation exposure:* Move the victim to fresh air *immediately*.

If the victim is not breathing, clean any chemical contamination from the victim's lips and perform cardiopulmonary resuscitation (CPR); if breathing is difficult, give oxygen.

4. *Ingestion exposure:* Seek medical attention if signs and symptoms of toxicity develop, or take the following steps if a large amount of barium sulfate is ingested:

- Have the victim rinse the contaminated mouth cavity several times with a fluid such as water.
- Have the victim drink a fluid such as water.

5. *Rescue:* Remove an incapacitated worker from further exposure and implement appropriate emergency procedures (e.g., those listed on the material safety data sheet required by OSHA's hazard communication standard [29 CFR 1910.1200]). All workers should be familiar with emergency procedures and the location and proper use of emergency equipment.

## EXPOSURE SOURCES AND CONTROL METHODS

The following operations may involve barium sulfate and may result in worker exposures to this substance:

- Mining, grinding, and bagging of barite and manufacture of barium sulfate
- Use of barium sulfate in oil-drilling muds, as a filler and delustrant for textiles, and as an expander in battery plate pastes
- Manufacture of lithopane, a white pigment
- Use of barium sulfate as a source of other barium compounds
- Manufacture of photographic papers, glass, ceramics, artificial ivory, cellophane, filler for rubber, linoleum, oil cloth, polymeric fibers and resins, and lithographic inks
- Use of barium sulfate as a diagnostic aid and X-ray contrast medium
- Use of barium sulfate as a watercolor pigment for colored paper and wallpaper, as an agent for modifying the colors of other pigments, and as an ingredient in the heavy concrete used for radiation shielding

The following methods are effective in controlling worker exposures to barium sulfate, depending on the feasibility of implementation:

- Process enclosure
- Local exhaust ventilation

—General dilution ventilation

—Personal protective equipment

Good sources of information about control methods are as follows:

1. ACGIH [1992]. *Industrial ventilation—a manual of recommended practice*. 21st ed. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.
2. Burton DJ [1986]. *Industrial ventilation—a self study companion*. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.
3. Alden JL, Kane JM [1982]. *Design of industrial ventilation systems*. New York, NY: Industrial Press, Inc.
4. Wadden RA, Scheff PA [1987]. *Engineering design for control of workplace hazards*. New York, NY: McGraw-Hill.
5. Plog BA [1988]. *Fundamentals of industrial hygiene*. Chicago, IL: National Safety Council.

## MEDICAL MONITORING

Workers who may be exposed to chemical hazards should be monitored in a systematic program of medical surveillance that is intended to prevent occupational injury and disease. The program should include education of employers and workers about work-related hazards, placement of workers in jobs that do not jeopardize their safety or health, early detection of adverse health effects, and referral of workers for diagnosis and treatment. The occurrence of disease or other work-related adverse health effects should prompt immediate evaluation of primary preventive measures (e.g., industrial hygiene monitoring, engineering controls, and personal protective equipment). A medical monitoring program is intended to supplement, not replace, such measures. To place workers effectively and to detect and control work-related health effects, medical evaluations should be performed (1) before job placement, (2) periodically during the term of employment, and (3) at the time of job transfer or termination.

### • Preplacement medical evaluation

Before a worker is placed in a job with a potential for exposure to barium sulfate, a licensed health care professional should evaluate and document the worker's baseline health status with thorough medical, environmental, and occupational histories, a physical examination, and physiologic and laboratory tests appropriate for the anticipated occupational risks. These should concentrate on the function and integrity of the respiratory system. Medical monitoring for respiratory disease should be conducted using the principles and methods recommended by the American Thoracic Society [ATS 1987].

A preplacement medical evaluation is recommended to assess an individual's suitability for employment at a specific job and to detect and assess medical conditions that may be aggravated or may result in increased risk when a worker is exposed to barium sulfate at or below the prescribed exposure limit. The licensed health care professional should consider the probable frequency, intensity, and duration of exposure as well as the nature and degree of any applicable medical condition. Such conditions (which should not be regarded as absolute contraindications to job placement) include a history and other findings consistent with respiratory system diseases.

- **Periodic medical examinations and biological monitoring**

Occupational health interviews and physical examinations should be performed at regular intervals during the employment period, as mandated by any applicable Federal, State, or local standard. Where no standard exists and the hazard is minimal, evaluations should be conducted every 3 to 5 years or as frequently as recommended by an experienced occupational health physician. Additional examinations may be necessary if a worker develops symptoms attributable to barium sulfate exposure. The interviews, examinations, and medical screening tests should focus on identifying the adverse effects of barium sulfate on the respiratory system. Current health status should be compared with the baseline health status of the individual worker or with expected values for a suitable reference population.

Biological monitoring involves sampling and analyzing body tissues or fluids to provide an index of exposure to a toxic substance or metabolite. No biological monitoring test acceptable for routine use has yet been developed for barium sulfate.

- **Medical examinations recommended at the time of job transfer or termination**

The medical, environmental, and occupational history interviews, the physical examination, and selected physiologic or laboratory tests that were conducted at the time of job placement should be repeated at the time of job transfer or termination. Any changes in the worker's health status should be compared with those expected for a suitable reference population.

## **WORKPLACE MONITORING AND MEASUREMENT**

A worker's exposure to airborne barium sulfate is determined by using a tared, low-ash polyvinyl chloride (LAPVC) filter (5-micron) to measure both total dust and the respirable fraction (a 10-mm nylon cyclone must be used for collecting

the respirable fraction). Samples are collected at a maximum flow rate of 2 liters/min (total dust) or 1.7 liters/min (respirable fraction) until a maximum air volume of 960 liters (total dust) or 816 liters (respirable fraction) is collected. Gravimetric analysis is conducted by weighing the filters. This method has a sampling and analytical error of 0.10 and is described in the *OSHA Industrial Hygiene Technical Manual* [OSHA 1985] and in the OSHA Computerized Information System (respirable fraction and total dust) [OSHA 1990]. A similar method is described in Method 500 (Nuisance dust, total) and Method 600 (Nuisance dust, respirable) of the *NIOSH Manual of Analytical Methods* [NIOSH 1984].

## **PERSONAL HYGIENE**

If barium sulfate contacts the skin, workers should immediately wash the affected areas with soap and water.

Clothing contaminated with barium sulfate should be removed to prevent physical irritation of the skin.

A worker who handles barium sulfate should thoroughly wash hands, forearms, and face with soap and water before eating, using tobacco products, or using toilet facilities.

Workers should not eat, drink, or use tobacco products in areas where barium sulfate is handled, processed, or stored.

## **STORAGE**

Barium sulfate should be stored in a cool, dry, well-ventilated area in tightly sealed containers that are labeled in accordance with OSHA's hazard communication standard [29 CFR 1910.1200]. Containers of barium sulfate should be protected from physical damage and should be stored separately from aluminum, heat, sparks, and open flame. Because containers that formerly contained barium sulfate may still hold product residues, they should be handled appropriately.

## **SPILLS**

In the event of a spill involving barium sulfate, persons not wearing protective equipment and clothing should be restricted from contaminated areas until cleanup is complete. The following steps should be undertaken following a spill or leak:

1. Do not touch the spilled material.
2. Notify safety personnel.
3. Remove all sources of heat and ignition.
4. Ventilate the area of the spill or leak.

5. For small, dry spills, use a clean shovel and place the material into a clean, dry, covered container; remove the container from the spill area.

## SPECIAL REQUIREMENTS

U.S. Environmental Protection Agency (EPA) requirements for emergency planning, reportable quantities of hazardous releases, community right-to-know, and hazardous waste management may change over time. Users are therefore advised to determine periodically whether new information is available.

### • Emergency planning requirements

Barium sulfate is not subject to EPA emergency planning requirements under the Superfund Amendments and Reauthorization Act (SARA) [42 USC 11022].

### • Reportable quantity requirements for hazardous releases

Employers are not required by the emergency release notification provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) [40 CFR 355.30] to notify the National Response Center of an accidental release of barium sulfate; there is no reportable quantity for this substance.

### • Community right-to-know requirements

Facilities in SIC codes 20 to 39 who employ 10 or more workers and who manufacture more than 25,000 lb of barium compounds (including barium sulfate) per calendar year or who use more than 10,000 lb of barium compounds per calendar year are required to comply with EPA requirements in 40 CFR 372 that mandate the submission of Toxic Chemical Release Inventory Forms.

### • Hazardous waste management requirements

EPA considers a waste to be hazardous if it exhibits any of the following characteristics: ignitability, corrosivity, reactivity, or toxicity as defined in 40 CFR 261.21-261.24. Although barium sulfate is not specifically listed as a hazardous waste under the Resource Conservation and Recovery Act (RCRA) [40 USC 6901 et seq.], EPA requires employers to treat waste as hazardous if it exhibits any of the characteristics discussed above.

Providing more information about the removal and disposal of specific chemicals is beyond the scope of this guideline. The U.S. Department of Transportation, EPA, and State and

local regulations should be followed to ensure that removal, transport, and disposal of this substance are conducted in accordance with existing regulations. To be certain that chemical waste disposal meets EPA regulatory requirements, employers should address any questions to the RCRA hotline at (800) 424-9346 or at (202) 382-3000 in Washington, D.C. In addition, relevant State and local authorities should be contacted for information about their requirements for waste removal and disposal.

## RESPIRATORY PROTECTION

### • Conditions for respirator use

Good industrial hygiene practice requires that engineering controls be used where feasible to reduce workplace concentrations of hazardous materials to the prescribed exposure limit. However, some situations may require the use of respirators to control exposure. Respirators must be worn if the ambient concentration of barium sulfate exceeds prescribed exposure limits. Respirators may be used (1) before engineering controls have been installed, (2) during work operations such as maintenance or repair activities that involve unknown exposures, (3) during operations that require entry into tanks or closed vessels, and (4) during emergencies. Workers should use only respirators that have been approved by NIOSH and the Mine Safety and Health Administration (MSHA).

### • Respiratory protection program

Employers should institute a complete respiratory protection program that, at a minimum, complies with the requirements of OSHA's respiratory protection standard [29 CFR 1910.134]. Such a program must include respirator selection, an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, fit testing, periodic workplace monitoring, and regular respirator maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program (including selection of the correct respirator) requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly. For additional information on the selection and use of respirators and on the medical screening of respirator users, consult the *NIOSH Respirator Decision Logic* [NIOSH 1987b] and the *NIOSH Guide to Industrial Respiratory Protection* [NIOSH 1987a].

## PERSONAL PROTECTIVE EQUIPMENT

Protective clothing should be worn if necessary to prevent skin contact with barium sulfate (gloves, boots, aprons, and gauntlets).

Safety glasses, goggles, or face shields should be worn during operations in which barium sulfate might contact the eyes (e.g., through dust particles). Eyewash fountains and emergency showers should be available within the immediate work area whenever the potential exists for eye or skin contact with barium sulfate. Contact lenses should not be worn if the potential exists for barium sulfate exposure.

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