**Bacitracin**

**B:0050**

**Molecular Formula:** C_{66}H_{103}N_{17}O_{16}S

**Synonyms:** Ayfivin; Baciguent; Baci-Jel; Baciliquin; Bacitek ointment; Fortracin; Parentracin; Penitracin; Topitracin; Zutracin

**CAS Registry Number:** 1405-87-4

**RTECS® Number:** CP0175000

**UN/NA & ERG Number:** UN3249 (medicine, solid, toxic, n.o.s.)/151

**EC Number:** 215-786-2

**Regulatory Authority and Advisory Bodies**

Listed on the TSCA inventory.


Listed on Canada’s DSL List.

WGK (German Aquatic Hazard Class): No value assigned.

**Description:** Bacitracin is a white to light tan powder which is odorless or having a slight odor and very bitter taste. Molecular weight = 1422.69; Freezing/Melting point: 221—224°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Highly soluble in water.

**Potential Exposure:** Bacitracin is used as an ingredient in antibiotic ointments to treat or prevent topical or eye infections. Commercial Bacitracin is a mixture of at least 9 bacitracs. Also used as a feed and drinking water additive in animals; as an additive in food for human consumption.

**Incompatibilities:** Oxidizers, such as peroxides, perchlorates, chlorates, nitrates, chlorine, bromine, and fluorine.

**Permissible Exposure Limits in Air**

No standards or TEEL available.

**Routes of Entry:** Through the skin, inhalation.

**Harmful Effects and Symptoms**

LD_{50} = (oral-mouse) 25 mg/kg (highly toxic). This data has been questioned, however, and it has been stated that as a result of a mathematical miscalculation, bacitracin was wrongly included in a list of hazardous chemicals drafted several years ago by the National Institute of Occupational Safety and Health. The mistake was remedied in 1988 when the substance was removed from the EHS list as noted above.

**Short Term Exposure:** Bacitracin can be absorbed through the skin, thereby increasing exposure. May cause eye irritation. Hypersensitivity reactions may result from application of this compound to the skin but this is uncommon. Exposure may cause nausea, vomiting, and diarrhea.

**Long Term Exposure:** May cause liver damage and skin allergy.

**Points of Attack:** Liver, skin.

**Medical Surveillance:** Evaluation by a qualified allergist. Kidney function tests.

**First Aid:** In case of large-scale exposure, the directions for medicines (nonspecific, n.o.s.) would be applied as follows: Move victim to fresh air; call emergency medical care. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact with material, immediately flush skin or eyes with running water for at least 15 min. Speed in removing material from skin is of extreme importance. Remove and isolate contaminated clothing and shoes at the site. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

**Storage:** Color Code—Green: General storage may be used.

**Shipping:** The DOT category of medicine, solid, toxic, n.o.s. calls for the label of “POISONOUS/TOXIC MATERIALS.” Bacitracin would fall in Hazard Class 6.1 and in Packing Group III.

**Spill Handling:** Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped.

OSHA 1910.120(q) may be applicable.

**Fire Extinguishing:** Use dry chemical, carbon dioxide, water spray, or polymer foam extinguishers. Poisonous gases are produced in fire, including carbon monoxide, nitrogen oxides, and sulfur oxides. Small fires: dry chemical, carbon dioxide, water spray, or foam. Large fires: water spray, fog, or foam. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Save fire control water for later disposal, do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

**References**

Washington, DC: Chemical Emergency Preparedness Program

**Barium**

**B:0100**

**Molecular Formula:** Ba  
**Synonyms:** Bario (Spanish); Barium, elemental; Barium metal

**CAS Registry Number:** 7440-39-3  
**RTECS® Number:** CQ8370000  
**UN/NA & ERG Number:** UN1400/138; UN1854 (alloys, pyrophoric)/135  
**EC Number:** 231-149-1

**Regulatory Authority and Advisory Bodies**  
Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.  
Water Pollution Standards Set (EPA) [49] (former USSR-UNEP/IRPTC project) [43] (Several States) [61] (Canada)

**US EPA Hazardous Waste Number (RCRA No.):** D005.  
**RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 100.0 mg/L.**  
**RCRA, 40CFR264, Appendix 9 Hazardous Constituents, waste number not listed.**  
**RCRA Maximum Concentration Limit for Ground Water Protection (40CFR264.94), 1.0 mg/L.**  
**RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 1.2; Nonwastewater (mg/L), 7.6 TCLP.**  
**RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List, Suggested methods (PQL µg/L): 6010 (20); 7080 (1000).**  
**Safe Drinking Water Act: MCL, 2 mg/L; MCLG, 2 mg/L; 6010 (20); 7080 (1000).**  
**WGK (German Aquatic Hazard Class): No value assigned.**

**Flammability 4, Reactivity 3**  
**Boiling pressure 10 mmHg at 1049°C.**  
**Freezing/Melting point 306°C.**  
**Inert gas in vacuum tubes and in alloys with nickel, lead, calcium, magnesium, sodium, and lithium.**  
**Incompatible with:** Flammable hydrogen gas and barium hydroxide.  
**Incompatible with:*** Barium is used for removal of residual gas in vacuum tubes and in alloys with nickel, lead, calcium, magnesium, sodium, and lithium. Barium compounds are used in the manufacture of lithopone (a white pigment in paints), chlorine, sodium hydroxide, valves, and green flares; in synthetic rubber vulcanization; X-ray diagnostic work, glassmaking, papermaking, beet-sugar purification; animal and vegetable oil refining. They are used in the brick and tile, pyrotechnics, and electronics industries. They are found in lubricants, pesticides, glazes, textile dyes, and finishes; pharmaceuticals; in cements which will be exposed to saltwater; and barium is used as a rodenticide, a flux for magnesium alloys, a stabilizer and mold lubricant in the rubber and plastics industries, an extender in paints; a loader for paper, soap, rubber, and linoleum; and as a fire extinguisher for uranium or plutonium fires.

**Permissible Exposure Limits in Air**  
**OSHA PEL:** 0.5 mg[Ba]/m³ TWA.  
**NIOSH REL:** 0.5 mg[Ba]/m³ TWA.  
**ACGIH TLV®[1]:** 0.5 mg[Ba]/m³ TWA; not classifiable as a human carcinogen.  
**NIOSH IDLH:** 50 mg Ba/m³.  
**PAC-1:** 1.5 mg/m³  
**PAC-2:** 50 mg/m³  
**PAC-3:** 50 mg/m³

**Soluble compounds only**  
**DFG MAK:** 0.5 mg[Ba]/m³, inhalable fraction TWA; Peak limitation II(2); Pregnancy Risk Group D.

**Australia:** TWA 0.5 mg/m³, 1993; Austria: MAK 0.5 mg/m³, 1993; Belgium: TWA 0.5 mg/m³, 1993; Denmark: TWA 0.5 mg/m³, 1999; Finland: TWA 0.5 mg/m³, 1999; Hungary STEL 0.5 mg/m³, 1993; the Netherlands: MAC-TGG 0.5 mg/m³, 2003; the Philippines: TWA 0.5 mg/m³, 1993; Poland: MAC (time-weighted average) 0.5 mg/m³; MAC (STEL) 1.5 mg/m³, 1999; Sweden: TWA 0.5 mg/m³, 1999; Switzerland: MAK-week 0.5 mg/m³, 1999; Turkey: TWA 0.5 mg/m³, 1993; United Kingdom: LTEL 0.5 mg/m³, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®; not classifiable as a human carcinogen. Several states have set guidelines or standards for barium in ambient air ranging from 0.67 μg/m³ (New York) to 5.0 μg/m³ (Florida and North Dakota) to 8.0 μg/m³ (Virginia) to 10.0 μg/m³ (Connecticut) to 12.0 μg/m³ (Nevada).

**Determination in Air:** Use NIOSH Analytical Methods (IV) #7056, Barium, soluble compounds. Collection on a cellulose membrane filter, workup with hot water, analysis by atomic absorption. Use NIOSH Analytical Method #8310, Metals in urine. OSHA ANALYTICAL METHOD ID-121.

**Permissible Concentration in Water:** EPA allows 2 ppm. See Regulatory Authority and Advisory Bodies for Canadian and Mexican levels. Russia [43] set a MAC of...
Determination in Water: Conventional flame atomization does not have sufficient sensitivity to determine barium in most water samples; however, a barium detection limit of 10 μg/L can be achieved if a nitrous oxide flame is used. A concentration procedure for barium uses thionyltrifluoroacetone—methylisobutylketone extraction at a pH of 6.8. With a tantalum liner insert, the barium detection limit of the flameless atomic absorption procedure can be improved to 0.1 μg/L according to NAS/NRC.[66]

Routes of Entry: Ingestion or inhalation of dust or fume, skin and/or eye contact.

Harmful Effects and Symptoms

Short Term Exposure: Alkaline barium compounds, such as the hydroxide and carbonate, may cause local irritation to the eyes, nose, throat, and skin. Exposure to either form can affect the nervous system and cause hypokalemia, which can cause heart disorders.

Long Term Exposure: Barium poisoning is virtually unknown in industry although the potential exists when the soluble forms are used. When ingested or given orally, the soluble, ionized barium compounds exert a profound effect on all muscles and especially smooth muscles, markedly increasing their contractility. The heart rate is slowed and may stop in systole. Other effects are increased intestinal peristalsis; vascular constriction; bladder contraction, and increased voluntary muscle tension. The inhalation of the dust of barium sulfate may lead to deposition in the lungs in sufficient quantities to produce baritosis (a benign pneumoconiosis). This produces a radiologic picture in the absence of symptoms and abnormal physical signs. X-rays, however, will show disseminated nodular opacities throughout the lung fields, which are discrete, but sometimes overlap. Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time.

Points of Attack: Heart, lungs, central nervous system, skin, respiratory system, eyes.

Medical Surveillance: Consideration should be given to the skin, eye, heart, and lung in any placement or periodic examination.

First Aid: If a soluble barium compound gets into the eyes, remove any contact lenses at once and irrigate immediately. If a soluble barium compound contacts the skin, flush with water immediately. If a person breathes in large amounts of a soluble barium compound, move the exposed person to fresh air at once and perform artificial respiration. When a soluble barium compound has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician (poisoning from barium compounds): If ingested, there are treatment considerations available including the following: Gastric emptying, a warm aqueous solution of 1–3% soluble sulfates of magnesium sulfate or sodium sulfate administered orally as a gastric lavage (forms insoluble barium sulfate). Atropine sulfate, 0.5–1.0 mg, to decrease colic. Small doses of morphine may be necessary to control abdominal pain. If low potassium (hypokalemia) is present, treat with IV of potassium.

Personal Protective Methods: Employees should receive instruction in personal hygiene and the importance of not eating in work areas. Good housekeeping and adequate ventilation are essential. Dust masks, respirators, or goggles may be needed where amounts of significant soluble or alkaline forms are encountered, as well as protective clothing.

Respirator Selection: 5 mg/m³: 95XQ (APF = 10) [any particular respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). 12.5 mg/m³: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). 25 mg/m³: 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). 50 mg/m³: Sa:F: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). Escape: 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Yellow Stripe (strong reducing agent): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Barium metal should be stored in a dry area, separated from halogenated solvents, strong oxidants, acids, in tightly-closed containers under an inert gas blanket, petroleum, or oxygen-free liquid. Rubber gloves, rubber protective clothing and apron, goggles and gas-filter mask should be worn when working in a barium storage area.

Shipping: Barium metal requires a shipping label of "DANGEROUS WHEN WET." The metal falls in
UN/DOT shipping class 4.3 and Packing Group II.\cite{19,20} It should be noted that “Barium Alloys” have the same caveats but “Barium Alloys, Pyrophoric” require a “SPONTANEOUSLY COMBUSTIBLE” label. They fall in hazard Class 4.2.

**Spill Handling:** Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Small quantities of barium metal may be dissolved in large quantities of water. Soda ash is added and the solution then neutralized with HCl. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

**Fire Extinguishing:** Barium powder is a flammable solid. Reacts violently with fire extinguishing agents, such as water, bicarbonate, powder, and carbon dioxide. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

**Disposal Method Suggested:** Barium in solution (see spill handling) may be precipitated with soda ash and the sludge may be landfilled.

**References**

**Barium azide**

**Molecular Formula:** BaN$_6$
**Common Formula:** Ba(N$_3$)$_2$
**Synonyms:** Azida de bario (Spanish)
**CAS Registry Number:** 18810-58-7
**RTECS® Number:** CQ8500000 (dry); CQ8510000 (wet)
**UN/NA & ERG Number:** UN1571 (dry or wetted with <50% water, by mass)/113
**EC Number:** 242-594-6

**Regulatory Authority and Advisory Bodies**
Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 5000 (commercial grade); *Theft hazard* 400 (commercial grade). Explosive Substance (World Bank).\cite{15}
Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.
EPCRA Section 313: Includes any unique chemical substance that contains barium as part of that chemical’s infrastructure. This category does not include barium sulfate (7727-43-7). Form R de minimis concentration reporting level: 0.1%.
Canada, WHMIS, Ingredients Disclosure List Concentration limitation II(2).
WGK (German Aquatic Hazard Class): No value assigned.

**Description:** Barium azide is a flammable, crystalline solid which can be used or transported in solution. Molecular weight = 221.4; Boiling point = explodes; Freezing/Melting point = 120°C (decomposes, losing nitrogen). Highly soluble in water.

**Potential Exposure:** Barium azide is used in high explosives.

**Incompatibilities:** Carbon disulfide. It can explode when heated or shocked.

**Permissible Exposure Limits in Air**
ACGIH TLV\cite{1}[T]: 0.5 mg[Ba]/m$^3$ TWA; not classifiable as a human carcinogen.
OSHA PEL: 0.5 mg[Ba]/m$^3$ TWA.
NIOSH REL: 0.5 mg[Ba]/m$^3$ TWA.
DFG MAK: 0.5 mg[Ba]/m$^3$, inhalable fraction TWA; Peak limitation II(2).
NIOSH IDLH: 50 mg Ba/m$^3$.
No TEEL available.

Several states have set guidelines or standards for barium in ambient air\cite{60} ranging from 0.67 μg/m$^3$ (New York) to 5.0 μg/m$^3$ (Florida and North Dakota) to 8.0 μg/m$^3$ (Virginia) to 10.0 μg/m$^3$ (Connecticut) to 12.0 μg/m$^3$ (Nevada).

**Determination in Air:** No criteria set for barium azide. See entry under “Barium.”
**Permissible Concentration in Water:** No criteria set for barium azide. EPA allows 2 ppm for barium. See entry under “Barium.”

**Routes of Entry:** Inhalation, skin and/or eyes.

**Harmful Effects and Symptoms**

**Short Term Exposure:** Barium azide irritates the eyes, nose, and respiratory tract; with coughing. Overexposure can cause a drop in blood pressure, with dizziness; blurred vision; headaches; and unconsciousness. Exposure to either form can affect the nervous system and cause hypokalemia, which can cause heart disorders.

**Long Term Exposure:** Repeated exposure to the dust can cause spots on chest X-ray without lung scarring. Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time.

**Points of Attack:** Lungs.

**Medical Surveillance:** Consideration should be given to the skin, eye, heart, and lung in any placement or periodic examination. Consider chest X-ray following acute overexposure.

**First Aid:** If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If weakness or fainting is present, lay the person down flat with feet elevated. See also First Aid section in “Barium” entry.

**Personal Protective Methods:** Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash- (for liquid) or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

**Respirator Selection:** (as soluble barium compounds)

- 5 mg/m³: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator).
- 12.5 mg/m³: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter).
- 25 mg/m³: 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece).
- 50 mg/m³: SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode).

**Shipping:** Barium azide wetted with not <50% water, by mass, requires a shipping label of “FLAMMABLE SOLID, POISONOUS/TOXIC MATERIALS.” It falls in Hazard Class 1.1A and Packing Group I.[19, 20] Barium azide dry or wetted with <50% water, by mass must be labeled “EXPLOSIVE, POISONOUS/TOXIC MATERIALS.” It falls in Hazard Class 1.1A and Packing Group II.[19, 20] Barium azide dry or wetted with <50% water, by mass must be labeled “EXPLOSIVE, POISONOUS/TOXIC MATERIALS.” It falls in Hazard Class 1.1A and Packing Group II.[19, 20] Barium azide dry or wetted with <50% water, by mass must be labeled “EXPLOSIVE, POISONOUS/TOXIC MATERIALS.” It falls in Hazard Class 1.1A and Packing Group II.[19, 20]

**Spill Handling:** Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of...
potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Barium azide will explode when heated or when shocked. If fire or explosion occurs, evacuate the area. Fight the fire from an explosion-resistant location as containers may explode in fire. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire, including nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

Barium bromate

Molecular Formula: BaBr₂O₄
Common Formula: Ba(BrO₃)₂
Synonyms: Bromato barico (Spanish); Bromic acid, barium salt
CAS Registry Number: 13967-90-3
RTECS® Number: EF8715000
UN/NA & ERG Number: UN2719/141
EC Number: 237-750-5

Regulatory Authority and Advisory Bodies
Carcinogenicity: EPA: Likely to produce cancer in humans (inhalation, as bromates); Available data are inadequate for an assessment of human carcinogenic potential (oral route, as bromates); Limited evidence of carcinogenicity based on epidemiologic studies.
Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.
EPCRA Section 313: Includes any unique chemical substance that contains barium as part of that chemical's infrastructure. This category does not include barium sulfate (7727-43-7). Form R de minimis concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) (Ba compounds, soluble, n.o.s.).
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as Barium, water-soluble compounds, n.o.s.
WGK (German Aquatic Hazard Class): No value assigned.

Description: Barium bromate is a white crystalline powder. Molecular weight = 411.2; Boiling point: explodes at 300°C; Freezing/Melting point = 260°C (decomposes). Slightly soluble in water.

Potential Exposure: This material is used as an analytical reagent, oxidizer, and corrosion inhibitor.

Incompatibilities: A strong oxidizer; keep away from reducing agents. Keep away from oxidizable materials; aluminum, arsenic, carbon, copper, metal sulfides; phosphorus, sulfur, organic, and combustible materials (such as wood, paper, oil, fuels) since violent reactions occur.

Permissible Exposure Limits in Air
ACGIH TLV®[1]: 0.5 mg[Ba]/m³ TWA; not classifiable as a human carcinogen.
OSHA PEL: 0.5 mg[Ba]/m³ TWA.
NIOSH REL: 0.5 mg[Ba]/m³ TWA.
DFG MAK: 0.5 mg[Ba]/m³, inhalable fraction TWA; Peak limitation II(2).
NIOSH IDLH: 50 mg Ba/m³.
No TEEL available.

Several states have set guidelines or standards for barium in ambient air ranging from 0.67 μg/m³ (New York) to 5.0 μg/m³ (Florida and North Dakota) to 8.0 μg/m³ (Virginia) to 10.0 μg/m³ (Connecticut) to 12.0 μg/m³ (Nevada).

Determination in Air: See entry under “Barium.”

Permissible Concentration in Water: No criteria set for barium bromate per se. EPA allows 2 ppm for barium. See entry under “Barium.”

Routes of Entry: Inhalation, skin and eye contact.

Harmful Effects and Symptoms
Short Term Exposure: Barium bromate can affect you when breathed in. Contact can irritate and even burn the eyes and skin. Breathing the dust or mist can irritate the nose, throat, and bronchial tubes, causing cough and phlegm. Exposure to either form can affect the nervous system and cause hypokalemia, which can cause heart disorders.

Long Term Exposure: After repeated exposure, barium may show up as spots on chest X-ray. Some barium chemicals are contaminated with silica, which scars the lungs. Repeated exposure to Barium bromate can cause bromine to build up in the body. Consult the sheet on “Bromine” entry. Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time. Repeated skin contact can cause chronic dryness and cracking.

Points of Attack: Lungs, skin.

Medical Surveillance: Serum bromide levels. Consideration should be given to the skin, eye, heart, and lung in any placement or periodic examination.
**First Aid:** If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. See also First Aid section in “Barium” entry.

**Personal Protective Methods:** Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/ clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

**Respirator Selection:** 5 mg/m	extsuperscript{3}: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). 12.5 mg/m	extsuperscript{3}: Sa: Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). 25 mg/m	extsuperscript{3}: 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaF: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). 50 mg/m	extsuperscript{3}: SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). **Emergency or planned entry into unknown concentrations or IDLH conditions:** SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

**Escape:** 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

**Storage:** Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where barium bromate is handled, used, or stored. Avoid any possible contact with incompatible materials. See OSHA Standard 1910.104 and NFPA 43A Code for the Storage of Liquid and Solid Oxidizers for detailed handling and storage regulations.

**Shipping:** Barium bromate requires a shipping label of “OXIDIZER, POISONOUS/TOXIC MATERIALS.” This material falls in Hazard Class 5.1 and Packing Group II.[19, 20]

**Spill Handling:** Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

**Fire Extinguishing:** Barium bromate explodes at 275–300°C. Extinguish fire using an agent suitable for type of surrounding fire. Barium bromate itself does not burn. Poisonous gases are produced in fire, including bromine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

**Reference**
Barium chlorate

**Molecular Formula:** BaCl$_2$O$_6$

**Common Formula:** Ba(ClO$_3$)$_2$

**Synonyms:** Barium chlorate (monohydrate); Chloric acid, barium salt; Clorato barico (Spanish)

**CAS Registry Number:** 13477-00-4 (monohydrate); 10326-27-7 (dihydrate)

**RTECS® Number:** FN9770000; CQ 8751000 (dihydrate)

**UN/NA & ERG Number:** UN1445

**EC Number:** 236-760-7

**Synonyms:** Barium chlorate; Clorato barico (Spanish)

**Common Formula:** Barium chlorate

**Molecular Formula:** BaCl$_2$O$_6$

**CAS Registry Number:** 13477-00-4

**RTECS® Number:** FN9770000; CQ 8751000

**UN/NA & ERG Number:** UN1445

**EC Number:** 236-760-7

**Synonyms:**

- Permissible Exposure Concentration in Water:
  - EPA allows 2 ppm for barium. See entry for “Barium.”

**Routes of Entry:** Inhalation, ingestion, eye and/or skin contact.

**Harmful Effects and Symptoms**

**Short Term Exposure:** Contact may burn the eyes and skin. Breathing the dust or mist can irritate the nose, throat, and bronchial tubes. Higher exposures can damage red blood cells. Symptoms include headache, weakness, abdominal pain, dark urine, and jaundice. The symptoms of paralysis may be delayed for several hours. Exposure to either form can affect the nervous system and cause hypokalemia, which can cause heart disorders.

**Long Term Exposure:** After repeated exposure, barium may show up as spots in the lungs on chest X-ray. Some barium chemicals are contaminated with silica, which scars the lungs. See entry for “Silica quartz.” Chlorates can damage red blood cells, leading to kidney damage, or cause methemoglobin to form in the blood, reducing oxygen supply to body organs. Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time. Repeated skin contact can cause chronic dryness and skin cracking.

**Medical Surveillance:** Lung function tests, complete blood count (CBC), test for methemoglobin. Consideration should be given to the skin, eye, heart, and lung in any placement or periodic examination.

**First Aid:**

- **Inhalation:** Remove to fresh air. If breathing is difficult, give artificial respiration. Keep warm and at rest. Provide breathing assistance if needed. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including

**Regulatory Authority and Advisory Bodies**

Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.

**Permissible Concentration in Water:** No criteria set for barium chloride per se. EPA allows 2 ppm for barium. See entry for “Barium.”

**Permissible Concentration in Water:** No criteria set for barium chloride per se. EPA allows 2 ppm for barium. See entry for “Barium.”

**Regulatory Authority and Advisory Bodies**

- **RTECS® Number:** FN9770000; CQ 8751000 (dihydrate)
- **UN/NA & ERG Number:** UN1445
- **EC Number:** 236-760-7
- **Synonyms:**
  - Permissible Exposure Concentration in Water:
    - EPA allows 2 ppm for barium. See entry for “Barium.”
  - **Routes of Entry:** Inhalation, ingestion, eye and/or skin contact.
  - **Harmful Effects and Symptoms**
    - **Short Term Exposure:** Contact may burn the eyes and skin. Breathing the dust or mist can irritate the nose, throat, and bronchial tubes. Higher exposures can damage red blood cells. Symptoms include headache, weakness, abdominal pain, dark urine, and jaundice. The symptoms of paralysis may be delayed for several hours. Exposure to either form can affect the nervous system and cause hypokalemia, which can cause heart disorders.
    - **Long Term Exposure:** After repeated exposure, barium may show up as spots in the lungs on chest X-ray. Some barium chemicals are contaminated with silica, which scars the lungs. See entry for “Silica quartz.” Chlorates can damage red blood cells, leading to kidney damage, or cause methemoglobin to form in the blood, reducing oxygen supply to body organs. Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time. Repeated skin contact can cause chronic dryness and skin cracking.
    - **Medical Surveillance:** Lung function tests, complete blood count (CBC), test for methemoglobin. Consideration should be given to the skin, eye, heart, and lung in any placement or periodic examination.
    - **First Aid:**
      - **Inhalation:** Remove to fresh air. If breathing is difficult, give artificial respiration. Keep warm and at rest. Provide breathing assistance if needed. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including

**Incompatibilities:**

- A strong oxidizer. When heated above 250°C, it begins to give off oxygen and will increase risk of fire. Barium chlorate is a reactive chemical and is an explosive hazard. Violent reaction may occur with reducing materials, strong acids, powdered metals. Contact with combustible materials will increase activity in fire.

**Incompatibilities:**

- A strong oxidizer. When heated above 250°C, it begins to give off oxygen and will increase risk of fire. Barium chlorate is a reactive chemical and is an explosive hazard. Violent reaction may occur with reducing materials, strong acids, powdered metals. Contact with combustible materials will increase activity in fire.

**Incompatibilities:**

- A strong oxidizer. When heated above 250°C, it begins to give off oxygen and will increase risk of fire. Barium chlorate is a reactive chemical and is an explosive hazard. Violent reaction may occur with reducing materials, strong acids, powdered metals. Contact with combustible materials will increase activity in fire.
resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. The symptoms of paralysis do not become obvious until some hours have passed. Keep under medical observation for 24–48 h. See also First Aid section in “Barium” entry.

*Note to physician:* Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

**Personal Protective Methods:** Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective work clothing. Wash thoroughly immediately after exposure to barium chlorate. Post hazard and warning information in the work area. In addition, as part of an ongoing education and training effort, communicate all information on the health and safety hazards of barium chlorate to potentially exposed workers.

**Respirator Selection:** (Ba soluble compounds) $5 \text{ mg/m}^3$: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). $12.5 \text{ mg/m}^3$: Sa: Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). $25 \text{ mg/m}^3$: PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and is operated in a continuous-flow mode).

**Storage:** Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Barium chlorate must be stored to avoid contact with organic or combustible materials (such as wood, paper, oil, fuels, and starch) and other easily oxidizable materials (such as sulfur, aluminum, copper, metal sulfides, ammonium salts, etc.) since violent reactions occur. Store in tightly closed containers on nonwood floors in a cool, well-ventilated area. Wherever barium chlorate is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

**Shipping:** This chemical requires a shipping label of “OXIDIZER, POISONOUS/TOXIC MATERIALS.” The Hazard Class is 5.1 and the Packing Group is II.\(^{19, 20}\)

**Spill Handling:** Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand, earth, or a similar nonorganic material and deposit in sealed containers. May also be covered with weak reducing agents; resulting sludge neutralized and flushed to sewer. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

**Fire Extinguishing:** May explode when heated. Contact with combustible, organic, or other easily oxidizable materials, such as paper, oil, fuels or sawdust can cause fires. Rubbing of these mixtures can cause explosions. Use water to extinguish the fire. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

**Disposal Method Suggested:** Use large volumes of reducing agent (bisulfite or ferrous salt) solutions. Neutralize and flush to sewer with large volumes of water.\(^{24}\)
Reference

Barium cyanide B:0140

Molecular Formula: BaC2N2
Common Formula: Ba(CN)2
Synonyms: Barium cyanide, solid; Barium dicyanide; Cianuro barico (Spanish)
CAS Registry Number: 542-62-1
RTECS® Number: CQ8785000
UN/NA & ERG Number: UN1565/157
EC Number: 208-822-3

Regulatory Authority and Advisory Bodies
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).
US EPA Hazardous Waste Number (RCRA No.): P013.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
Reportable Quantity (RQ): 10 lb (4.54 kg).
RCRA Land Ban Waste Restrictions.
EPCRA Section 313: as barium compounds; Form R de minimis concentration reporting level: 0.1%.
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide compounds.
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/92).
US EPA Hazardous Waste Number (RCRA No.): P013.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents.
Reportable Quantity (RQ): 10 lb (4.54 kg).
RCRA Land Ban Waste Restrictions.
EPCRA Section 313: as barium compounds; Form R de minimis concentration reporting level: 0.1%.
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide compounds.
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).
US EPA Hazardous Waste Number (RCRA No.): P030 as cyanides, soluble salts and complexes, n.o.s.
RCRA, 40CFR261, Appendix 8 Hazardous Constituents. as cyanides, soluble salts and complexes, n.o.s.
EPCRA Section 313: X + CN − where X = H + or any other group where a formal dissociation may occur. For example, KCN or Ca(CN)2; Form R de minimis concentration reporting level: 1.0%.
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide mixtures, cyanide solutions or cyanides, inorganic, n.o.s.
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as Barium, water-soluble compounds, n.o.s. and Cyanide compounds, inorganic, n.o.s.
European/International Regulations: Hazard Symbol: T, N; Risk phrases: R28; R32; R50/53; Safety phrases: S1/2; S7/8; S23; S36/37; S45; S60; S61 (see Appendix 4).
WGK (German Aquatic Hazard Class): 3—Severe hazard to waters.

Description: Barium cyanide is a white crystalline powder. Often used in solution. Molecular weight = 139.4; Heat of combustion = −60.5 × 10^3 J/kg; Heat of solution = (exothermic) = −6.19 × 10^3 J/kg. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water; solubility = 80 g/100 cc at 14 °C.

Potential Exposure: Barium cyanide is used in electroplating and in metallurgy.

Incompatibilities: Violent reactions may occur on contact with acids, acid salts, and strong oxidizers.

Permissible Exposure Limits in Air
ACGIH TLV®: 0.5 mg[Ba]/m^3 TWA; not classifiable as a human carcinogen.
OSHA PEL: 0.5 mg[Ba]/m^3 TWA.
NIOSH REL: 0.5 mg[Ba]/m^3 TWA.
NIOSH IDLH: 50 mg [Ba]/m^3.
Protective Action Criteria (PAC)
TEEL-0: 0.69 mg/m^3
PAC-1: 2.07 mg/m^3
PAC-2: 3.5 mg/m^3
PAC-3: 69 mg/m^3
DFG MAK: 0.5 mg[Ba]/m^3, inhalable fraction TWA; Peak limitation II(2).
Australia: TWA 5 mg/m^3, [skin], 1993; Austria: MAK 5 mg [CN/m^3, [skin], 1999; Denmark: TWA 5 mg/m^3, [skin], 1999; France: VME 5 mg[CN]/m^3, [skin], 1999; Poland: TWA 0.3 mg[CN]/m^3, ceiling 10 mg[CN]/m^3, 1999; Switzerland: MAK-W 5 mg/m^3, KZG-W 10 mg/m^3, [skin], 1999; United Kingdom: TWA 5 mg[CN]/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: Ceiling Concentration 5 mg/m^3 [skin]. Several states have set guidelines or standards for barium in ambient air[60] ranging from 0.67 μg/m^3 (New York) to 5.0 μg/m^3 (Florida and North Dakota) to 8.0 μg/m^3 (Virginia) to 10.0 μg/m^3 (Connecticut) to 12.0 μg/m^3 (Nevada).

Permissible Concentration in Water: No criteria set for barium cyanide per se. EPA allows 2 ppm for barium. See entry under “Barium.” See also entry under “Cyanides.”

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Passes through the skin.

Harmful Effects and Symptoms

Short Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Barium cyanide is a deadly poison; can affect you when breathed and by passing through skin. Exposure can cause confusion, weakness, headaches, nausea, vomiting, gasping for air, collapse and even death from cyanide poisoning. On contact with acids, acid mists, or acid salts, flammable hydrogen cyanide gas is formed which can cause rapid poisoning. Exposure to either form can affect the nervous system and cause hypokalemia, which can cause heart disorders.

Long Term Exposure: Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time. Can interfere with the normal functioning of the thyroid gland, causing goiter (enlarged thyroid).
**Points of Attack:** Thyroid.

**Medical Surveillance:** Blood cyanide level. Thyroid function tests. Consideration should be given to the skin, eye, heart, and lung in any placement or periodic examination.

**First Aid:** If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

**Respirator Selection:** (Ba soluble compounds) 5 mg/m^3: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). 12.5 mg/m^3: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). 25 mg/m^3: 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHe (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). 50 mg/m^3: SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

**Escape:** 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

**Storage:** Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Barium cyanide must be stored to avoid contact with acids; acid salt (such as potassium bisulfate, calcium biphosphate and calcium nitrate); carbon dioxide and strong oxidizers (such as nitrates, chlorates and chlorine) since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area.

**Shipping:** This chemical requires a shipping label of “POISONOUS/TOXIC MATERIALS.” The Hazard Class is 6.1 and the Packing Group is I[19, 20]

**Spill Handling:** Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Ventilate the area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers.

**Fire Extinguishing:** Barium cyanide does not burn, but contact with acids, acid salts, or carbon dioxide in air may produce highly flammable hydrogen cyanide gas. Extinguish fire using an agent suitable for type of surrounding fire. Poisonous gases are produced in fire, including cyanide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated...
waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

**Disposal Method Suggested:** Precipitate barium with sulfuric acid. Then add with stirring to alkaline calcium hypochlorite solution. Let stand 24 h, then flush to sewer.

**References**

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**Barium hypochlorite**  B:0150

**Molecular Formula:** BaCl₂O₂

**Common Formula:** Ba(OCl)₂

**Synonyms:** Hypochlorous acid, barium salt

**CAS Registry Number:** 13477-10-6

**RTECS® Number:** NH3480000

**UN/NA & ERG Number:** UN2741 (barium hypochlorite, with more than 22% available chlorine)/141

**Regulatory Authority and Advisory Bodies**
Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.
EPCRA Section 313: Includes any unique chemical substance that contains barium as part of that chemical’s infrastructure. This category does not include barium sulfate (7777-43-7). Form R de minimis concentration reporting level: 0.1%.
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) (Ba compounds, soluble, n.o.s.).
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as Barium, water-soluble compounds, n.o.s.
WGK (German Aquatic Hazard Class): No value assigned.

**Description:** Barium hypochlorite is a colorless, sand-like, crystalline solid, often used in solution. A strong oxidizer. There is not much information available on this compound. Reacts with water.

**Potential Exposure:** This material is used as a bleaching agent and as an antiseptic.

**Incompatibilities:** Barium hypochlorite is a strong oxidizer. Avoid contact with reducing agents, organic and combustible materials (such as wood, oil, paper, and fuels), acids, and urea since violent reactions occur. Keep away from water or steam.

**Permissible Exposure Limits in Air**

ACGIH TLV®[1]: 0.5 mg[Ba]/m³ TWA; not classifiable as a human carcinogen.
OSHA PEL: 0.5 mg[Ba]/m³ TWA.
NIOSH REL: 0.5 mg[Ba]/m³ TWA.
DFG MAK: 0.5 mg[Ba]/m³, inhalable fraction TWA; Peak limitation II(2).
NIOSH IDLH: 50 mg Ba/m³.
No TEEL available.
Several states have set guidelines or standards for barium in ambient air[60] ranging from 0.67 μg/m³ (New York) to 5.0 μg/m³ (Florida and North Dakota) to 8.0 μg/m³ (Virginia) to 10.0 μg/m³ (Connecticut) to 12.0 μg/m³ (Nevada).

**Determination in Air:** See entry under “Barium.”

**Permissible Concentration in Water:** No standards set for Barium Hypochlorite per se. EPA allows 2 ppm for barium. See entry under “Barium.”

**Routes of Entry:** Inhalation, ingestion, eye and/or skin contact. Absorbed through the skin.

**Harmful Effects and Symptoms**

**Short Term Exposure:** Barium hypochlorite can affect you when breathed in and may enter the body through the skin. Contact can irritate and even burn the eyes and skin. Breathing the dust or mist can irritate the nose, throat, and bronchial tubes, causing cough and phlegm. Exposure to either form can affect the nervous system and cause hypokalemia, which can cause heart disorders.

**Long Term Exposure:** After repeated exposure, barium may show up as spots in the lungs on chest X-ray. Some barium chemicals are contaminated with silica, which scars the lungs. Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time. Repeated skin contact can cause chronic dryness and cracking.

**Points of Attack:** Lungs, skin.

**Medical Surveillance:** Consideration should be given to the skin, eye, heart, and lung in any placement or periodic examination.

**First Aid:** If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective work clothing. Wash thoroughly immediately after exposure to barium hypochlorite and at the end of the work shift. Post hazard and warning information in the work area. In addition, as part of an ongoing education and training effort, communicate all information on the health and safety hazards of barium hypochlorite to potentially exposed workers. See also First Aid section in “Barium” entry.

Respirator Selection: (BA soluble compounds) 5 mg/m³: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). 12.5 mg/m³: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). 25 mg/m³: 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or Sa:T: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprThie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). 50 mg/m³: SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). Escape: 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Store in tightly closed containers in a cool, well-ventilated area away from water and steam. Sources of ignition, such as smoking and open flames, are prohibited where Barium Hypochlorite is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Avoid any possible contact with the incompatible materials cited above. See OSHA Standard 1910.104 and NFPA 43A Code for the Storage of Liquid and Solid Oxidizers for detailed handling and storage regulations.

Shipping: Barium hypochlorite (with more than 22% available chlorine) requires an “OXIDIZER” label. It falls in Hazard Class 5.1 and Packing Group II.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Do not use water. Extinguish fire using an agent suitable for type of surrounding fire. Barium hypochlorite itself does not burn. Poisonous gases are produced in fire, including chlorine and chlorides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (vent sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

Barium nitrate

Molecular Formula: BaN₂O₆
Common Formula: Ba(NO₃)₂
Synonyms: Barium dinitrate; Nitrate de baryum (French); Nitrato barico (Spanish); Nitric acid, barium salt
CAS Registry Number: 10022-31-8
RTECS® Number: CQ9625000
UN/NA & ERG Number: UN1446/141
EC Number: 233-020-5
Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.
EPCRA Section 313: Includes any unique chemical substance that contains barium as part of that chemical’s infrastructure. This category does not include barium sulfate (7727-43-7). Form R de minimis concentration reporting level: 0.1%.

US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) (Ba compounds, soluble, n.o.s.).

Canada, WHMIS, Ingredients Disclosure List Concentration 1.0%.

European/International Regulations: not listed in Annex 1.

Permissible Concentration in Water: No criteria set for barium. EPA allows 2 ppm for barium. See entry for “Barium.”

Routes of Entry: Inhalation.

**Harmful Effects and Symptoms**

**Short Term Exposure:** Barium nitrate can affect you when breathed in. Inhaling dust or mist can cause irritation of the respiratory system, causing cough and phlegm. Contact can irritate and even burn the eyes and skin. Exposure can irritate the eyes, nose, and throat. Very high exposure (such as swallowing or extremely high dust exposure) can cause barium poisoning with symptoms of vomiting and diarrhea, irregular heartbeat, paralysis, and death. Exposure to either form can affect the nervous system and cause hypokalemia, which can cause heart disorders. LD50 = (oral-rat) 355 mg/kg.

**Long Term Exposure:** Repeated high exposure can irritate the lungs, causing cough and phlegm, and may cause an abnormal chest X-ray. Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time.

**Points of Attack:** Lungs, nervous system, heart.

**Medical Surveillance:** Consideration should be given to the skin, eye, heart, and lung in any placement or periodic examination.

**First Aid:** If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. See also First Aid section in “Barium” entry.

**Personal Protective Methods:** Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

**Respirator Selection:** (Ba soluble compounds) 5 mg/m3: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator).
12.5 mg/m^3: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). 50 mg/m^3: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). Escape: 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). Evacuate and restrict persons not wearing respiratory protectors recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

**Disposal Method Suggested:** Dissolve waste in 6-M HCl. Neutralize with NH4OH. Precipitate with excess sodium carbonate. Filter, wash, and dry precipitate and return to supplier.

**References**

**Barium oxide**

**Molecular Formula:** BaO

**Synonyms:** Barium monoxide; Barium protoxide; Barya; Calcined baryta; Monoxide barico (Spanish); Oxyde de baryum (French)

**CAS Registry Number:** 1304-28-5

**RTECS® Number:** CQ9800000

**UN/NA & ERG Number:** UN1884/157

**EC Number:** 215-127-9

**Regulatory Authority and Advisory Bodies**
Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.
EPCRA Section 313: Includes any unique chemical substance that contains barium as part of that chemical’s infrastructure. This category does not include barium sulfate (7727-43-7). Form R de minimis concentration reporting level: 0.1%.
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) (Ba compounds, soluble, n.o.s.).
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as Barium, water-soluble compounds, n.o.s.
European/International Regulations: not listed in Annex 1.
Barium oxide

WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

**Description:** Barium oxide is a white to yellowish-white, odorless powder. Molecular weight = 153.34; Freezing/Melting point = 1923°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 2®. Reacts violently with water.

**Potential Exposure:** It is used to dry gases and solvents and in producing detergents for lubricating oils.

**Incompatibilities:** Reacts with water, forming barium hydroxide. Violent reactions occur on contact with hydrogen sulfide, carbon dioxide; hydroxylamine, nitrogen tetroxide or sulfur trioxide. Reacts with triuranium.

**Permissible Exposure Limits in Air**

ACGIH TLV®: 0.5 mg[Ba]/m³ TWA; not classifiable as a human carcinogen.

OSHA PEL: 0.5 mg[Ba]/m³ TWA.

NIOSH REL: 0.5 mg[Ba]/m³ TWA.

**Protective Action Criteria (PAC)**

- TEEL-0: 0.558 mg/m³
- PAC-1: 1.67 mg/m³
- PAC-2: 2.79 mg/m³
- PAC-3: 5.58 mg/m³

**DFG MAK:** 0.5 mg[Ba]/m³, inhalable fraction TWA; Peak limitation II(2).

NIOSH IDLH: 50 mg Ba/m³.

Several states have set guidelines or standards for barium in ambient air ranging from 0.67 μg/m³ (New York) to 5.0 μg/m³ (Florida and North Dakota) to 8.0 μg/m³ (Virginia) to 10.0 μg/m³ (Connecticut) to 12.0 μg/m³ (Nevada).

**Determination in Air:** See entry for “Barium.”

**Permissible Concentration in Water:** No criteria set for barium oxide per se. EPA allows 2 ppm for barium. See entry for “Barium.”

**Determination in Water:** Harmful to the environment.

**Routes of Entry:** Inhalation.

**Harmful Effects and Symptoms**

**Short Term Exposure:** Barium oxide can affect you when breathed in. Contact can irritate the skin and burn the eyes, causing loss of vision. Breathing the dust or mist can irritate the nose, throat, and bronchial tubes, causing cough and phlegm. High exposure may cause pulmonary edema, a medical emergency, that can be delayed for several hours. This can cause death. Exposure to this chemical can affect the nervous system and cause hypokalemia, which can cause heart disorders.

**Long Term Exposure:** May cause lung irritation and bronchitis. After repeated exposure, barium may show up as spots in the lungs on chest X-ray. Some barium chemicals are contaminated with silica, which scars the lungs. Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time.

**Points of Attack:** Lungs, nervous system, heart.

**Medical Surveillance:** Consideration should be given to the skin, eye, heart, and lung in any placement or periodic examination.

**First Aid:** If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24–48 h after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray. See also First Aid section in “Barium” entry.

**Personal Protective Methods:** Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

**Respirator Selection:** (Ba soluble compounds) 5 mg/m³, 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). 12.5 mg/m³: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). 25 mg/m³: 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaF: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). 50 mg/m³: SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a
pressure-demand or other positive-pressure mode). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp; ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). Escape: 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a dry, cool, well-ventilated area away from water and the incompatible substances cited above.

Shipping: Barium oxide requires a shipping label of “POISONOUS/TOXIC MATERIALS.” This material falls in Hazard Class 6.1 and Packing Group III. [19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. NEVER pour water into this substance; when dissolving or diluting always add it slowly to the water. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Barium oxide itself does not burn. Do not use water. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference
New Jersey Department of Health and Senior Services. (June 2002). Hazardous Substances Fact Sheet: Barium Oxide. Trenton, NJ

Barium perchlorate

Molecular Formula: BaCl₂O₄
Common Name: Ba(ClO₄)₂
Synonyms: Barium perchlorate trihydrate; Perchloric acid, barium salt; Perchlorato barico (Spanish)
CAS Registry Number: 13465-95-7
RTECS® Number: SC7550000
UN/NA & ERG Number: UN1447/141
EC Number: 236-710-4 [Annex I Index No.: 017-007-00-X]

Regulatory Authority and Advisory Bodies
Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.
EPCRA Section 313: Includes any unique chemical substance that contains barium as part of that chemical’s infrastructure. This category does not include barium sulfate (7727-43-7). Form R de minimis concentration reporting level: 0.1%.
US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) (Ba compounds, soluble, n.o.s.).
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as Barium, water-soluble compounds, n.o.s.
European/International Regulations: Hazard Symbol: O, Xn; Risk phrases: R9; R20/22; Safety phrases: S2; S27 (see Appendix 4).
WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

Description: Barium perchlorate is a white crystalline solid. Molecular weight = 336.2; Freezing/Melting point = 400°C (trihydrate); 505°C (anhydrous). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Highly soluble in water; solubility = 200 g/100 mL at 33°C.

Potential Exposure: It is used to make explosives and in experimental rocket fuels.

Incompatibilities: An oxidizing agent. Contact with organic and combustible materials (such as paper, wood, and oil), finely divided metals (specifically magnesium and aluminum), sulfur, calcium hydride, and strontium hydride since violent reactions occur.

Permissible Exposure Limits in Air
ACGIH TLV®(1): 0.5 mg[Ba]/m³ TWA; not classifiable as a human carcinogen.
OSHA PEL: 0.5 mg[Ba]/m³ TWA.
NIOSH REL: 0.5 mg[Ba]/m³ TWA.
DFG MAK: 0.5 mg[Ba]/m³, inhalable fraction TWA; Peak limitation II(2).
NIOSH IDLH: 50 mg Ba/m³.
No TEEL available.
Several states have set guidelines or standards for barium in ambient air ranging from 0.67 μg/m³ (New York) to 5.0 μg/m³ (Florida and North Dakota) to 8.0 μg/m³ (Virginia) to 10.0 μg/m³ (Connecticut) to 12.0 μg/m³ (Nevada).
Determination in Air: See entry for “Barium.”
Permissible Concentration in Water: No criteria set for Barium perchlorate per se. EPA allows 2 ppm for barium. See entry for “Barium.”
Routes of Entry: Inhalation.
Harmful Effects and Symptoms
Short Term Exposure: Barium perchlorate can affect you when breathed in. Contact can cause severe irritation and burn the eyes and skin. Breathing the dust or mist can irritate the nose, throat, and bronchial tubes, causing cough and phlegm. Overexposure can cause methemoglobinemia, causing dizziness, bluish color to the skin and lips. Higher levels can cause difficult breathing, collapse, and even death.
Long Term Exposure: After repeated exposure, Barium may show up as spots in the lungs on X-ray. Some Barium chemicals are contaminated with silica, which scars the lungs. Perchlorates can interfere with thyroid function, affect the red blood cells (methemoglobinemia) or damage bone marrow (aplastic anemia). Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time.
Points of Attack: Lungs, red blood cells.
Medical Surveillance: Consideration should be given to the skin, eye, heart, and lung in any placement or periodic examination. Thyroid function tests, complete blood count (CBC), tests for methemoglobin.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine. See also First Aid section in “Barium” entry.
Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: (Ba soluble compounds) 5 mg/m³; 9.5X (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). 12.5 mg/m³: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PapHR (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). 25 mg/m³: 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaF: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PapTH (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). 50 mg/m³: SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). Escape: 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).
Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Store in tightly closed containers in a cool, well-ventilated area away from heat sources, sources of shock, or the incompatible materials cited above. Sources of ignition, such as smoking and open flames, are prohibited where Barium perchlorate is handled, used, or stored. See OSHA Standard 1910.104 and NFPA 43A Code for the Storage of Liquid and Solid Oxidizers for detailed handling and storage regulations.
Shipping: Barium perchlorate requires a shipping label of “OXIDIZER, POISONOUS/TOXIC MATERIALS.” This material falls in Hazard Class 5.1 and Packing Group II.19, 20
Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquids in
vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

**Fire Extinguishing:** Barium perchlorate does not burn, but contact with organic and combustible materials or heat or shock may cause fires or explosions. In case of fire, evacuate the area and fight the fire from a safe, protected location. Poisonous gases are produced in fire, including Chlorides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

**Reference**


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**Barium permanganate**  
**B:0190**

**Molecular Formula:** BaMn<sub>2</sub>O<sub>8</sub>  
**Common Formula:** Ba(MnO<sub>4</sub>)<sub>2</sub>  
**Synonyms:** Barium manganate(VIII); Permanganato barico (Spanish); Permanganic acid, barium salt  
**CAS Registry Number:** 7787-36-2  
**RTECS® Number:** SD6405000  
**UN/NA & ERG Number:** UN1448/141  
**EC Number:** 232-110-1  
**Regulatory Authority and Advisory Bodies**  
Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.  
EPCRA Section 313: Includes any unique chemical substance that contains barium as part of that chemical’s infrastructure. This category does not include barium sulfate (7727-43-7). Form R de minimis concentration reporting level: 0.1%.  
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as Barium, water-soluble compounds, n.o.s.  
WGK (German Aquatic Hazard Class): No value assigned.  
**Description:** Barium permanganate is a brownish-violet, dark purple to black crystalline solid. Molecular weight = 375.2; Specific gravity (H<sub>2</sub>O:1) = 3.77 at 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Soluble in water.  
**Potential Exposure:** It is used to make dry cells and other permnaganates; and as a disinfectant.  
**Incompatibilities:** Acetic acid, acetic anhydride, and organic or combustible materials (such as wood, paper, oil, and fuels) since violent reactions occur.  
**Permissible Exposure Limits in Air**  
ACGIH TLV<sup>n</sup>[1]: 0.5 mg[Ba]/m<sup>3</sup> TWA; not classifiable as a human carcinogen.  
OSHA PEL: 0.5 mg[Ba]/m<sup>3</sup> TWA.  
NIOSH REL: 0.5 mg[Ba]/m<sup>3</sup> TWA.  
Protective Action Criteria (PAC)  
TEEL-0: 6.83 mg/m<sup>3</sup>  
PAC-1: 20.5 mg/m<sup>3</sup>  
PAC-2: 34.1 mg/m<sup>3</sup>  
PAC-3: 34.1 mg/m<sup>3</sup>  
DFG MAK: 0.5 mg[Ba]/m<sup>3</sup>, inhalable fraction TWA; Peak limitation II(2).  
NIOSH IDLH: 50 mg Ba/m<sup>3</sup>.  
Several states have set guidelines or standards for barium in ambient air ranging from 0.67 μg/m<sup>3</sup> (New York) to 5.0 μg/m<sup>3</sup> (Florida and North Dakota) to 8.0 μg/m<sup>3</sup> (Virginia) to 10.0 μg/m<sup>3</sup> (Connecticut) to 12.0 μg/m<sup>3</sup> (Nevada).  
**Determination in Air:** See entry for “Barium.”  
**Permissible Concentration in Water:** No criteria set for barium permanganate per se. EPA allows 2 ppm for barium. See entry for “Barium.”  
**Routes of Entry:** Inhalation.  
**Short Term Exposure:** Skin and eye contact can cause severe irritation and burns. Barium permanganate can affect you when breathed in. Breathing the dust or mist can irritate the nose, throat, and bronchial tubes, causing cough and phlegm. Exposure to either form can affect the nervous system and cause hypokalemia, which can cause heart disorders.  
**Long Term Exposure:** After repeated exposure, Barium may show up as spots in the lungs on chest X-ray. Some barium chemicals are contaminated with Silica, which scars the lungs. Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time. Repeated contact may cause chronic drying and cracking skin.
Points of Attack: Lungs, skin.
Medical Surveillance: Consideration should be given to the skin, eye, heart, and lung in any placement or periodic examination.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. See also First Aid section in “Barium” entry.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Post hazard and warning information in the work area. In addition, as part of an ongoing education and training effort, communicate all information on the health and safety hazards of Barium permanganate to potentially exposed workers.

Respirator Selection: (Ba soluble compounds) 5 mg/m³: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). 12.5 mg/m³: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). 25 mg/m³: 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece). 50 mg/m³: Sa: Pd, Pp (APF = 1000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd, Fp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). Escape: 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Store in tightly closed containers in a cool, well-ventilated area. Keep away from incompatible materials cited above. See OSHA Standard 1910.104 and NFPA 43A Code for the Storage of Liquid and Solid Oxidizers for detailed handling and storage regulations.

Shipping: Barium permanganate requires a shipping label of “OXIDIZER, POISONOUS/TOXIC MATERIALS.” This material falls in Hazard Class 5.1 and Packing Group II.[19, 20]

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Barium permanganate does not burn, but contact with organic and combustible materials may cause fires or explosions. In case of fire, evacuate the area and fight the fire from a safe, protected location. Poisonous gases are produced in fire. If material or contaminated run-off enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only
respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference

**Barium peroxide** B:0200

*Molecular Formula:* BaO₂

*Synonyms:* Barium binoxide; Barium dioxide; Bariumpermoxid (German); Barium superoxide; Dioxyde de baryum (French); Peroxido barico (Spanish); Peroxyde de baryum (French)

*CAS Registry Number:* 1304-29-6

*RTECS® Number:* CR0175000

*UN/NA & ERG Number:* UN1449/141

*EC Number:* 215-128-4 [Annex I Index No.: 056-001-00-1]

**Regulatory Authority and Advisory Bodies**

*Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.*

*RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents.*

*EPCRA Section 313: Includes any unique chemical substance that contains barium as part of that chemical’s infrastructure. This category does not include barium sulfate (7727-43-7). Form R de minimis concentration reporting level: 0.1%.*

*US DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).* Canad., WHMIS, Ingredients Disclosure List Concentration 1.0% as Barium, water-soluble compounds, n.o.s. European/International Regulations: Hazard Symbol: O, Xn; Risk phrases: R8; R20/22; Safety phrases: S2; S13; S27 (see Appendix 4). WGK (German Aquatic Hazard Class): 1—Low hazard to waters.

*Description:* Barium peroxide is a grayish-white powder. Molecular weight = 169.34; Specific gravity (H₂O:1) = 4.98; Boiling point = 800°C (decomposes below this point); Freezing/Melting point = 450°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 2, W, Oxidizer. Very slightly soluble in water.

*Potential Exposure:* Is used as a bleaching agent; in making hydrogen peroxide, oxygen; in aluminum welding; in textile dyeing and for bleaching fibers; animal substances.

*Incompatibilities:* A strong oxidizer. Keep away from organic and combustible materials (such as wood, paper, oil, fuels, and other easily oxidized materials) and peroxymetric acid, hydrogen sulfide, and hydroxylamine solutions since violent reactions occur.

**Permissible Exposure Limits in Air**

ACGIH TLV®[1]: 0.5 mg[Ba]/m³ TWA; not classifiable as a human carcinogen.

OSHA PEL: 0.5 mg[Ba]/m³ TWA.

NIOSH REL: 0.5 mg[Ba]/m³ TWA.

*Protective Action Criteria (PAC)*

TEEL-0: 0.617 mg/m³

PAC-1: 1.5 mg/m³

PAC-2: 12.5 mg/m³

PAC-3: 61.7 mg/m³

DFG MAK: 0.5 mg[Ba]/m³, inhalable fraction TWA; Peak limitation II(2).

NIOSH IDLH: 50 mg Ba/m³.

Australia: TWA 0.5 mg/m³, 1993; Austria: MAK 0.5 mg/m³, 1993; Belgium: TWA 0.5 mg/m³, 1993; Denmark: TWA 0.5 mg/m³, 1999; Finland: TWA 0.5 mg/m³, 1999; Hungary STEL 0.5 mg/m³, 1993; the Netherlands: MAC-TGG 0.5 mg/m³, 2003; the Philippines: TWA 0.5 mg/m³, 1993; Poland: MAC (time-weighted average) 0.5 mg/m³; MAC (STEL) 1.5 mg/m³, 1999; Sweden: TWA 0.5 mg/m³, 1999; Switzerland: MAK-week 0.5 mg/m³, 1999; Turkey: TWA 0.5 mg/m³, 1993; United Kingdom: LTEL 0.5 mg/m³, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®: not classifiable as a human carcinogen. Several states have set guidelines or standards for barium in ambient air[60] ranging from 0.67 μg/m³ (New York) to 5.0 μg/m³ (Florida and North Dakota) to 8.0 μg/m³ (Virginia) to 10.0 μg/m³ (Connecticut) to 12.0 μg/m³ (Nevada).

**Determination in Air:** See entry under “Barium.”

**Permissible Concentration in Water:** No criteria set for Barium peroxide per se. EPA allows 2 ppm for barium. See entry under “Barium.”

**Determination in Water:** Environmental hazard for aquatic organisms.

**Routes of Entry:** Inhalation, ingestion.

**Harmful Effects and Symptoms**

**Short Term Exposure:** Barium peroxide can affect you when breathed in. Contact can irritate and burn the eyes and skin. Breathing the dust or mist can irritate the nose, throat, and bronchial tubes, causing cough and phlegm. Exposure to this chemical can affect the nervous system and cause hypokalemia, which can cause heart disorders.

**Long Term Exposure:** After repeated exposure, Barium may show up as spots in the lungs on chest X-ray. Some barium chemicals are contaminated with silica, which scars the lungs. Repeated contact may cause chronic drying and cracking skin. Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time.

**Points of Attack:** Lungs, skin.

**First Aid:** If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with...
soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

**Personal Protective Methods:** Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

**Respirator Selection:** (Ba soluble compounds) 5 mg/m³: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) [any supplied-air respirator].

12.5 mg/m³: Sa:CF (APF = 25) [any supplied-air respirator operated in a continuous-flow mode] or PparThie (APF = 25) [any powered, air-purifying respirator with a high-efficiency particulate filter]. 25 mg/m³: 100F (APF = 50) [any air purifying, full-face-piece respirator with an N100, R100, or P100 filter] or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

**Storage:** Color Code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Store in tightly closed containers in a cool, well-ventilated area away from water or moisture, and away from contact with the incompatible materials cited above. See OSHA Standard 1910.104 and NFPA 43A Code for the Storage of Liquid and Solid Oxidizers for detailed handling and storage regulations.

**Shipping:** This chemical requires a shipping label of “OXIDIZER, POISONOUS/TOXIC MATERIALS.” This material falls in Hazard Class 5.1 and Shipping Group II.[19, 20]

**Spill Handling:** Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Cover material with sand/soda ash 9:1 mixture. Mix thoroughly and while stirring, add slowly to sodium bisulfite solution with plastic implements. Neutralize with dilute H₂SO₄. After setting, decant the solution with flushing water and transport the sand to a sanitary landfill.[24] Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

**Fire Extinguishing:** Barium peroxide does not burn, but mixtures of Barium peroxide and combustible, organic, or easily oxidized materials, such as wood, fuels, paper, and charcoal will burn or explode if rubbed or contact a small amount of water. Use large amounts of water to extinguish the fire. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

**Disposal Method Suggested:** See Spill Handling.

**Reference**
Barium sulfate  

**Molecular Formula:** BaO₂S  
**Common Formula:** BaSO₄  
**Synonyms:** Acetybaryte; Artificial brite; Artificial heavy spar; Bakontal; Baridol; Barite; Baritop; Barosperse; Barotrast; Baryta white; Barytes; Bayrites; Blanc fixe (French); C.I. 77120.C.I.; Citobaryum; Colonatrasl; Enamel white; Esophotrasl; Eweisse-Z-paque; E-Z-paque; Finemetal; Lactobaryt; Liquobarine; Macropaque; Neobar; Oratrasl; Permanent white; Pigment white 21; Polybar; Precipitated barium sulphate; Radiobaryt; Raybar; Redi-Flow; Solbar; Sulfato barico (Spanish); Sulfuric acid, barium salt (1:1); Supramike; Travad; Unibaryt  
**CAS Registry Number:** 7727-43-7  
**RTECS® Number:** CR0600000  
**UN/NA & ERG Number:** UN1564/154  
**EC Number:** 231-784-4  
**Regulatory Authority and Advisory Bodies**  
Air Pollutant Standard Set. See below, “Permissible Exposure Limits in Air” section.  
RCRA, 40CFR261, Appendix 8 Hazardous Constituents, as barium compounds, n.o.s., waste number not listed.  
EPCRA Section 313: This does not cover barium sulfate (7727-43-7).  
Canada, WHMIS, Ingredients Disclosure List Concentration 1.0% as Barium, water-soluble compounds, n.o.s.  
WGK (German Aquatic Hazard Class): Nonwater polluting agent.  
**Description:** Barium sulfate is a white crystalline solid. Molecular weight = 233.40; Freezing/Melting point = 1580°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Slightly soluble in water.  
**Potential Exposure:** Barium sulfate is used as an opaque medium in radiography; as a mud weighting material in oil well drilling; in paper coating; as a paint pigment.  
**Incompatibilities:** Aluminum powder, phosphorus.  
**Permissible Exposure Limits in Air**  
OSHA PEL: 15 mg/m³, total dust TWA; 5 mg/m³, respirable fraction TWA.  
NIOSH REL: 10 mg/m³, total dust TWA; 5 mg/m³, respirable fraction TWA.  
ACGIH TLV®[1]: 10 mg/m³ TWA.  
Protective Action Criteria (PAC)  
TEEL-0: 15 mg/m³  
PAC-1: 30 mg/m³  
PAC-2: 350 mg/m³  
PAC-3: 500 mg/m³  
DFG MAK: 1.5 mg/m³ respirable fraction (previously “fine dust”); 4 mg/m³ inhalable fraction (previously “total dust”).  
Pregnancy Risk group C.  
Australia: TWA 10 mg/m³, 1993; Austria: MAK 0.5 mg(Ba)/m³, 1999; Belgium: TWA 10 mg/m³ (respirable dust), 1993; Denmark: TWA 0.5 mg(Ba)/m³, 1999; Finland: TWA 0.5 mg (Ba)/m³, 1999; Norway: TWA 0.5 mg(Ba)/m³, 1999; Sweden: TWA 0.5 mg(Ba)/m³, 1999; the Netherlands: MAC-TGG 0.5 mg(Ba)/m³; MAC-TGG 1.5 mg/m³ (respirable dust), 2003; MAC-TGG 4 mg/m³ (total dust), 2003; United Kingdom: TWA (respirable dust) 4 mg(Ba)/m³, 2000; United Kingdom: TWA 10 mg(Ba)/m³ (total dust), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV®; TWA 10 mg/m³.  
**Determination in Air:** Barium sulfate may be determined by filtration and gravimetric measurement.  
**Permissible Concentration in Water:** EPA allows 2 ppm for barium.  
**Routes of Entry:** Inhalation of dust; ingestion.  
**Harmful Effects and Symptoms**  
**Short Term Exposure:** Irritates eyes and respiratory tract. Exposure to either form can affect the nervous system and cause hypokalemia, which can cause heart disorders.  
**Long Term Exposure:** Lungs may be affected by repeated or prolonged exposure to dust particles, resulting in baritosis (a form of benign pneumoconiosis) (WHO). Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time.  
**Points of Attack:** Lungs, nervous system, heart.  
**Medical Surveillance:** Consideration should be given to the skin, eyes, heart, and lung in any placement or periodic examination.  
**First Aid:** If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 min, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been swallowed, induce vomiting, rinse out mouth, then rinse with water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, rinse mouth and get medical attention immediately due to the possibility of barium poisoning. See also “First Aid” section in “Barium” entry.  
**Personal Protective Equipment:** Wear protective gloves and clothing to prevent any reasonable probability of skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: 5 mg/m³: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face-pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100] or Sa (APF = 10) (any supplied-air respirator). 12.5 mg/m³: Sa: Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). 25 mg/m³: 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting face-piece and is operated in a continuous-flow mode) or PaprHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting face-piece and a high-efficiency particulate filter) or SCBAF (APF = 50) (any self-contained breathing apparatus with a full face-piece) or SaF (APF = 50) (any supplied-air respirator with a full face-piece). 50 mg/m³: SaF: Pd, Pp (APF = 2000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd, Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). Escape: 100F (APF = 50) (any air purifying, full-face-piece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Barium sulfate requires a shipping label of “POISONOUS/TOXIC MATERIALS.” Barium compounds, n.o.s. fall in Hazard Class 6.1 and Shipping Group III.19, 20

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Poisonous gases are produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full face-pieces and are operated in a pressure-demand or other positive-pressure mode.

Reference