The following information was generated from the Hazardous Substances Data Bank (HSDB), a database of the National Library of Medicine's TOXNET system (http://toxnet.nlm.nih.gov) on April 22, 2016.

Query: The chemical name bromine was identified.
The following terms were added from ChemIDplus:
broom  dutch
bromo  italian
brom  german
brome  french
CAS Registry Number: 7726-95-6

1 - HSDB
TOXICITY SUMMARY:
IDENTIFICATION AND USE: Bromine is a dark reddish-brown, volatile, mobile diatomic liquid; vaporizes at room temperature. Pure bromine is used in the synthesis of a variety of bromine containing substances. Other uses for bromine include flame retardants, cleaning agents, dyestuffs, photography, water sanitation, pharmaceuticals, bleaching fibers and silk. Bromine is registered for use in water filters to purify drinking water aboard US Naval ships and offshore oil well platforms. It is also used as a general disinfectant and sanitizer in indoor, non-food contact areas such as commercial establishments, hospitals and households, to control bacteria and fungi. HUMAN EXPOSURE AND TOXICITY: Inhalation of the irritant bromine vapors or direct contact with the liquid or vapor with skin and mucous membranes will produce direct tissue injury. Injury may occur at various levels of the respiratory tract depending upon the concentration of bromine and the duration of exposure. Pure bromine liquid or vapor is extremely irritating to the skin. Unlike other chemical agents, there is no immediate visible skin reaction after contact. The delay before initial signs or injury become apparent often results in more extreme damage. The most common local effects are blister formation, brownish discoloration of the skin and slow healing ulcers. Exposure to low concentrations produces lacrimation, rhinorrhea, eye irritation, coughing, dyspnea, choking, wheezing, epistaxis and headache. A brownish discoloration of the tongue and buccal mucosa may result and be accompanied by a characteristic breath odor. Inflammatory lesions of the upper airway, photophobia and blepharospasm are noted at higher levels. Upper and lower respiratory tract: delayed or immediate bronchoconstriction and the development of laryngeal spasm, glottal edema and asthma. With increased parenchymal penetration, there may be associated peribronchiolar abscesses, pulmonary infiltrates consistent with chemical pneumonitis, bronchiolitis obliterans and pulmonary edema. Acute obstructive ventilator impairment may lead to acidosis, measles like rash and subsequent death. It should be noted that more severe respiratory symptoms may be delayed for several hours after the exposure. There is a rare cutaneous manifestation of bromide accumulation known as bromoderma tuberosum which progresses from red papules to pustules that enlarge and develop into indurated lesions. A mild degree of spermatogenic suppression and impaired reproductive performance following paternal exposure to bromine vapor described in the literature. ANIMAL STUDIES: The
mortality of mice exposed to 240 or 750 ppm bromine was dependent on the duration of the study. Rats, mice and rabbits inhaling 0.2 ppm bromine developed disturbances in the functions of their respiratory, nervous and endocrine systems. Rats fed bromine (0.01 mg/kg) for 6 months experienced changes in their conditioned reflexes and several blood indexes.

ECOTOXICITY STUDIES: Bromine releases as a consequence of production activities have had serious effects upon vegetation.**PEER REVIEWED**

HUMAN TOXICITY EXCERPTS:

/SIGNS AND SYMPTOMS/ Dermal: There is a rare cutaneous manifestation of bromide accumulation known as bromoderma tuberosum, which progresses from red papules to pustules that enlarge and develop into indurated lesions with a central ulcer. This effect is related to the ingestion of bromides formerly used in medications and, in theory, to chronic inhalation of low-level concentrations of bromine.[IPCS INCHEM; Poisons Information Monographs, Bromine (PIM 080). Available from, as of June 25, 2007: http://www.inchem.org/pages/pims.html] **PEER REVIEWED**

/SIGNS AND SYMPTOMS/ Dermal: Pure bromine (liquid or vapor) is extremely irritating to the skin. Unlike most other chemical agents, there is no immediate visible skin reaction after contact. The delay before initial signs of injury become apparent often results in more extensive damage. The most common local effects are blister formation, brownish discoloration of the skin and slow-healing ulcers.[IPCS INCHEM; Poisons Information Monographs, Bromine (PIM 080). Available from, as of June 25, 2007: http://www.inchem.org/pages/pims.html] **PEER REVIEWED**

/SIGNS AND SYMPTOMS/ Skin burns can occur from liquid bromine spills. Bromine initially causes a cooling effect on the skin and after a delay will produce a burning sensation that can progress to deep chemical burns and brown discoloration of the skin.[Sullivan, J.B., Krieger G.R. (eds). Clinical Environmental Health and Toxic Exposures. Second edition. Lippincott Williams and Wilkins, Philadelphia, Pennsylvania 1999., p. 967] **PEER REVIEWED**

/SIGNS AND SYMPTOMS/ Upper and lower respiratory tract: Initial irritant symptoms of bromine vapor inhalation include: dyspnea, coughing, choking, and wheezing. In addition, immediate or delayed bronchoconstriction and the development of laryngeal spasm, glottal edema, asthma and tracheobronchitis. With increased parenchymal penetration, there may be associated peribronchiolar abscesses, pulmonary infiltrates consistent with chemical pneumonitis, bronchiolitis obliterans and pulmonary edema. Acute obstructive ventilatory impairment may lead to severe hypoxemia, metabolic acidosis, measles-like rash and subsequent death. It should be noted that more severe respiratory symptoms may be delayed for several hours after the exposure.[IPCS INCHEM; Poisons Information Monographs, Bromine (PIM 080). Available from, as of June 25, 2007: http://www.inchem.org/pages/pims.html] **PEER REVIEWED**

/SIGNS AND SYMPTOMS/ Mucous Membranes: Exposure to low concentrations produces lacrimation, rhinorrhea, eye irritation with mucous secretions from the oropharyngeal and upper airways, coughing, dyspnea, choking, wheezing, epistaxis, and headache. A brownish discoloration of the tongue and buccal mucosa may occur and be accompanied by a characteristic breath
odor. Inflammatory lesions of the upper airway, photophobia and blepharospasm are seen with higher concentrations.[IPCS INCHEM; Poisons Information Monographs, Bromine (PIM 080). Available from, as of June 25, 2007: http://www.inchem.org/pages/pims.html] **PEER REVIEWED**

/SIGNS AND SYMPTOMS/ symptoms ... following inhalation of ... small amt include coughing, nosebleed, feeling of oppression, dizziness, & headache, followed after some hours by abdominal pain & diarrhea, & sometimes by measleslike eruptions on trunk & extremities. ... Pustules & furuncles appear in exposed areas of skin of those who handle bromine ... brief contact of liq with skin leads to ... vesicles & pustules. If not removed at once, it induces deep, painful ulcers.[Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley & Sons. New York, N.Y. (2001)., p. 3:802] **PEER REVIEWED**


/SIGNS AND SYMPTOMS/ Bromine is a lacrimator at concentrations below 6.5 mg/ cu m.[European Chemicals Bureau; IUCLID Dataset, Bromine (CAS # 7726-95-6) p.37 Available from, as of June 19, 2007: http://esis.jrc.ec.europa.eu/] **PEER REVIEWED**

/SIGNS AND SYMPTOMS/ Clinical description: The majority of exposures to bromine occur by inhalation and typically lead to symptoms of ocular, nasal, and respiratory irritation. Signs and symptoms of poisoning include eye redness and lacrimation, nose and throat irritation, cough, and dyspnea. Ingestion of liquid bromine can cause abdominal pain and hemorrhagic gastroenteritis with secondary shock. Signs and symptoms might also include brown discoloration of mucous membranes and the tongue.[CDC: Chemical Emergencies. Case Definition. Bromine. (March 4, 2005). Available from, as of June 12, 2007: http://www.bt.cdc.gov/agent/bromine/pdf/casedef.pdf] **PEER REVIEWED**

/CASE REPORTS/ A maintenance technician in a chemical company developed a cough with severe bronchospasm and spontaneous pneumomediastinum following an accidental exposure to bromine. The chest radiograph on admission was normal and only a surveillance chest x-ray taken a few hours later demonstrated the presence of pneumomediastinum. ...[IPCS INCHEM; Poisons Information Monographs, Bromine (PIM 080). Available from, as of June 25, 2007: http://www.inchem.org/pages/pims.html] **PEER REVIEWED**

/CASE REPORTS/ A 21-year-old male had a chemical burn on the right forearm when he inadvertently spilled bromine during an experiment. Since he inhaled vaporized bromine and had dyspnea and pharyngalgia, he arrived at ... /the/ hospital as an emergency patient. On arrival, he /was conscious/ with a pulse rate of 98, body temperature of 36.8 degrees C, blood pressure of 132/80 mm Hg, respiratory rate of 25, and oxygen saturation of 100%. (10 L/min of oxygen were administered.) He had marked dry coughs. His clothes had a foreign odor with mucosal irritation. Arterial blood gas analysis and blood biochemistry were normal. Based on
these findings, he was diagnosed with chemical airway damage and bulbar conjunctivitis from the exposure to bromine and a chemical burn on the right forearm. His respiratory condition became worse after admission, resulting in pulmonary edema. He was endotracheally intubated and controlled with an artificial ventilator on Day 3 after his injury. He was continuously treated with steroids and sivelestat sodium hydrate, which gradually improved his respiration. He was released from the artificial ventilator and extubated on Day 7. Although dyspnea associated with body movement and hoarseness persisted after extubation, the symptoms decreased and he was discharged on Day 41. ...[Inagaki N et al; Chudoku Kenkyu 18 (2): 141-7 (2005)] **PEER REVIEWED**

/Case Reports/ A study was undertaken to evaluate spermatogenesis and reproductive performance among 8 men and their spouses following accidental exposure to bromine vapor. Of the three cases with oligo-terato- asthenozoospermia (OTA), one had been diagnosed prior to and unrelated to the event. Mild OTA and unimpaired reproductive performance characterized the other two cases. Plasma levels of the follicle stimulating hormone and luteinizing hormone were normal in all men. One first-trimester abortion and one late abortion (due to chorioamnionitis) occurred among the 5 pregnancies conceived shortly after the accident. Results of the present study suggest a mild degree of spermatogenic suppression and impaired reproductive performance following paternal exposure to bromine vapor during the above described accident. However, due to the small size of the study cohort, a cause-result linkage could not be established.[European Commission/European Chemical Substances Information System (ESIS); IUCLID Dataset, Bromine (7726-95-6) p. 35 (2000). Available from, as of October 2, 2014: http://esis.jrc.ec.europa.eu/] **PEER REVIEWED**

/Case Reports/ 6 people suffered acute accidental exposure to bromine vapor. During the exposure they only had some respiratory symptoms and skin burns of first to second degree involving small areas. All were treated in hospital and released within 1-4 days. 6-8 weeks later, some still had health complaints, such as cough, shortness of breath, chest tightness, eye irritation, headache, dizziness, fatigue, and memory, sleep and sexual disturbances; but there was no objective laboratory or clinical evidence of effects.[European Commission/European Chemical Substances Information System (ESIS); IUCLID Dataset, Bromine (7726-95-6) p. 35 (2000). Available from, as of October 2, 2014: http://esis.jrc.ec.europa.eu/] **PEER REVIEWED**

/Case Reports/ A case of chemical pneumonitis in a female laboratory assistant exposed to bromine and bromine compounds was described. The patient had worked as a laboratory assistant in the flavor research department of a chemical company for 17 years and had no history of smoking or previous lung disease. Symptoms developed following an accident in which the patient was splashed with a mixture of bromine, phosphorus-tribromide, and hydrogen-bromide. The initial symptoms included a dry cough, light headedness, and slight congestion of the throat and were followed by increasing shortness of breath and the development of bibasilar crackles over a 2 week period. Chest x-rays
indicated bilateral lower lobe infiltrates, and the patient was hospitalized with bilateral lower lobe and right upper lobe chemical pneumonitis. Therapy involved treatment with oral prednisone. Post treatment complications included severe flu syndrome, pneumonia, and persistent dyspnea on exertion. Chemical pneumonitis recurred with new infiltrates in both right upper and right midlung fields a few months after the patient returned to work. According to the authors, the recurrence of respiratory symptoms and pulmonary infiltrates without resolution of the initial pneumonitis suggested bronchiolitis obliterans. [Kraut A Lilis R; Chest 94(1): 208-210 (1988)] **PEER REVIEWED**

/CASE REPORTS/ A case of pneumomediastinum induced by exposure to bromine was described. A 21 year old male was exposed to bromine leaking from a ruptured check valve while exchanging pipes at a chemical company where he was employed as a maintenance technician. The patient was coughing and choking at admission to an emergency ward. He showed tachypnea, diffuse expiratory wheezes, and prolonged expirium. The anterior chest and face had chemical burns. His eyes were not injured as he had been wearing protective glasses. No abnormalities were seen on a chest X-ray. He was given oxygen and an intravenous infusion of aminophylline and hydrocortisone and admitted to the intensive care unit. A few hours later he still experienced severe cough. A second chest X-ray revealed pneumomediastinum. Subcutaneous emphysema or chemical pneumonitis was not seen. The patient showed gradual progressive improvement and the pneumomediastinum resolved. The patient was discharged four days after admission. Subsequent surveillance chest X-rays and pulmonary function tests were normal. /This study concluded/ that irritation of the airways by bromine resulted in coughing and transient respiratory obstruction which led to rupture of marginal alveoli and mediastinal emphysema in the patient. [Lossos IS et al; British Journal of Industrial Medicine 47 (11): 784 (1990)] **PEER REVIEWED**

/CASE REPORTS/ The case of a 29 yr old woman with classical manifestations of bromoderma on both legs was diagnosed by a positive bromine test. The disorder was due to a depilatory cream. The bromoderma did not appear until 8 yr after the 1st application of the cream. Whether the bromoderma is a toxic manifestation caused by a reduction of the skin pH by bromine, a biotropic manifestation caused by bromine-induced rise in virulence of saprophytic organisms especially of staphylococci or an allergic manifestation caused by sensitization of the skin by bromine is unresolved. [RIBOLDI A et al; G ITAL DERMATOL-MINERVA DERMATOL; 46 (7): 327-329 (1971)] **PEER REVIEWED**

/CASE REPORTS/ In November 1984, due to an accident at a chemical plant, toxic bromine gas spread into the town of Geneva, Switzerland, at concentrations over five times the maximal admissible concentration (MAC). Monitoring of atmospheric bromine concentrations allowed the determination both of the duration of exposure and the geographical area concerned. Description of the immediate measures taken at the time of the accident illustrates how mass panic reactions can be generated or controlled, and clearly shows the vital importance of an effective communication network: it was lacking in this case and caused further insecurity for the population and isolation of the hospital. Immediate and systematic data
collection enabled us to carry out an "acute" epidemiological survey of the accident. It is the first report of mass bromine intoxication in the medical literature. 91 patients with symptoms of bromine exposure were seen in the outpatient and casualty departments of the cantonal Hospital, but the clinical course was mild and self-limited in nearly all cases. One patient was admitted for 24 hours. The most common symptoms were upper respiratory tract symptoms, cough and headache. In 20-30% of cases these persisted for more than three days, and sometimes up to one month. Recording the location of patients at the time when their first symptoms occurred made it possible to define the exposed area with precision.

...[Morabia A et al; Schweiz Med Wochenschr 116 (1): 11-8 (1986)] **PEER REVIEWED**

/SURVEILLANCE/ A survey of the effects of bromine and bromine compounds on liver and thyroid function in chemical workers was conducted. Hematological changes induced by exposure were also assessed. The cohort consisted of 140 workers employed in the production of elemental bromine, bromide salts, and methyl-bromide at a chemical facility. Fifty nonexposed individuals constituted the comparisons. Fasting blood sugar and blood sugar after galactose load, serum bilirubin and cholesterol, hippuric-acid synthesis, plasma prothrombin, hemoglobin, leukocyte, erythrocyte and platelet counts, erythrocyte sedimentation rates, and uptake of iodine-131 by the thyroid were determined. The exposed workers showed moderate hypoglycemia, irritative type pathological blood sugar curves, hypercholesterolemia, reduction in total bilirubin, leukopenia, a tendency toward decreased hemoglobin concentration, increased erythrocyte sedimentation rates, and decreased uptake of iodine-131 by the thyroid. The other parameters were not significantly different from those of the comparisons. /The conclusion of this study is/ that the observed changes are related to early (preclinical) and nonspecific reactions of the body. He recommends that all workers involved in producing bromine, bromide salts, and methyl-bromide be given periodic medical examinations. Measures should be implemented to reduce emissions of vapors and dusts from the compounds.[Shapovalov YuD; Vrachebnoe Delo 12: 110-115 (1974)] **PEER REVIEWED**

/BIOMONITORING/ The use of serum bromine levels for biomonitoring of occupational bromine exposure was examined. Serum bromine levels were assessed using X-ray fluorescence in workers from a company producing bromine compounds. The average serum bromine level was 22.9 parts per million. Significantly more men worked in manufacturing compared with women. Male workers had a significantly higher mean serum bromine level compared with female workers. The serum bromine concentrations of male workers were independently related to age, country of origin, education, and smoking. A consistent relationship was also seen between serum bromine level and work site, department, and occupation. Those who worked in the production facility, manufacturing and packaging departments, or in manufacturing jobs had higher average serum bromine levels. The lowest levels were seen in chemical laboratory workers. High serum bromine levels were also seen in workers who handled the chemicals. Only 3.9% of the women in the study fell into the upper three deciles of serum bromine level compared with 33% of the men. The authors conclude that serum
bromine monitoring appears to be useful for the assessment of occupational bromine exposure in chemical workers.[Eldan M et al; Journal of Occupational and Environmental Medicine, 38 (10):1026-1031(1996)] **PEER REVIEWED**

/ALTERNATIVE and IN VITRO TESTS/ Parameters of bromine injury were studied in vitro with the use of full-thickness human skin (HS) specimens - discards from various surgical procedures. The morphology of in vitro-treated HS resembled that of in vivo-injured skin. The damage was pronounced in the epidermis (destruction of the stratum corneum, and extensive vacuolation of keratinocytes) and the dermis (collagen coagulation), depending on the bromine concentration, exposure time, and application method. A decreased viability of epidermal cells, assayed by dye exclusion, was observed as well. Permeation parameters of bromine via abdominal HS were determined by quantitating bromine concentration in the donor and receiving compartments. The amount of bromine that permeated HS was inversely related to the concentration gradient applied. This in vitro study suggests that prompt treatment and early medical intervention may be required for successful healing of both severe and mild cases of bromine injuries.[ELIAZ R et al; JOURNAL OF BURN CARE &amp; REHABILITATION; 19 (1 PART 1):18-24 (1998)] **PEER REVIEWED**

HUMAN TOXICITY VALUES:
An oral dose of 1 mL is regarded as lethal in adults.[European Commission/European Chemical Substances Information System (ESIS); IUCLID Dataset, Bromine (7726-95-6) p. 40 (2000). Available from, as of October 2, 2014: http://esis.jrc.ec.europa.eu/] **PEER REVIEWED**

Concentration of 11-23 mg/cu m produces severe choking ... 30-60 mg/cu m is extremely dangerous ... 200 mg/cu m would prove fatal in very short time ... vapors can cause acute as well as chronic poisoning .. it has cumulative properties ..[European Commission/European Chemical Substances Information System (ESIS); IUCLID Dataset, Bromine (7726-95-6) p. 37 (2000). Available from, as of October 2, 2014: http://esis.jrc.ec.europa.eu/] **PEER REVIEWED**

SKIN, EYE AND RESPIRATORY IRRITATIONS:

Irritating concn 2.10 mg/cu m[Ruth JH; Am Ind Hyg Assoc J 47: A-142-51 (1986)] **PEER REVIEWED**

Bromine is a lacrimator at concentrations below 6.5 mg/cu m.[European Commission/European Chemical Substances Information System (ESIS); IUCLID Dataset, Bromine (7726-95-6) p. 35 (2000). Available from, as of October 2, 2014: http://esis.jrc.ec.europa.eu/] **PEER REVIEWED**

A toxic vapor, very irritating to eyes and respiratory tract ... respiratory damage occurs at 10 ppm.[European Commission/European Chemical Substances Information System (ESIS); IUCLID Dataset, Bromine (7726-95-6)
MEDICAL SURVEILLANCE:
Laboratory criteria for diagnosis: Biologic: No specific test for bromine is available; however, detection of elevated bromide levels in serum (reference level is 50-100 mg/L) might indicate that an exposure has occurred.[CDC: Chemical Emergencies. Case Definition. Bromine. (March 4, 2005). Available from, as of June 12, 2007: http://www.bt.cdc.gov/agent/bromine/pdf/casedef.pdf] **PEER REVIEWED**

PROBABLE ROUTES OF HUMAN EXPOSURE:
According to the 2012 TSCA Inventory Update Reporting data, the number of persons reasonably likely to be exposed in the industrial manufacturing, processing, and use of bromine is 100 to 999; the data may be greatly underestimated(1).[(1) US EPA; Chemical Data Reporting (CDR). Non-confidential 2012 Chemical Data Reporting information on chemical production and use in the United States. Available from, as of Oct 14, 2014: http://www.epa.gov/cdr/pubs/guidance/cdr_factsheets.html] **PEER REVIEWED**

NIOSH (NOES Survey 1981-1983) has statistically estimated that 62,214 workers (10,780 of these are female) are potentially exposed to bromine in the US(1). Occupational exposure to bromine may occur through inhalation and dermal contact with this compound at workplaces where bromine is produced or used(SRC).[1) NIOSH; NOES. National Occupational Exposure Survey conducted from 1981-1983. Estimated numbers of employees potentially exposed to specific agents by 2-digit standard industrial classification (SIC). Available from, as of Oct 10, 2014: http://www.cdc.gov/noes/] **PEER REVIEWED**

REPORTED FATAL DOSE:
An oral dose of 1 mL is regarded as lethal in adults.[European Commission/European Chemical Substances Information System (ESIS); IUCLID Dataset, Bromine (7726-95-6) p. 40 (2000). Available from, as of October 2, 2014: http://esis.jrc.ec.europa.eu/] **PEER REVIEWED**

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TOXICITY SUMMARY:
IDENTIFICATION AND USE: Bromine is a dark reddish-brown, volatile, mobile diatomic liquid; vaporizes at room temperature. Pure bromine is used in the synthesis of a variety of bromine containing substances. Other uses for bromine include flame retardants, cleaning agents, dyestuffs, photography, water sanitation, pharmaceuticals, bleaching fibers and silk. Bromine is registered for use in water filters to purify drinking water aboard US Naval ships and offshore oil well platforms. It is also used as a general disinfectant and sanitizer in indoor, non-food contact areas
such as commercial establishments, hospitals and households, to control bacteria and fungi. HUMAN EXPOSURE AND TOXICITY: Inhalation of the irritant bromine vapors or direct contact with the liquid or vapor with skin and mucous membranes will produce direct tissue injury. Injury may occur at various levels of the respiratory tract depending upon the concentration of bromine and the duration of exposure. Pure bromine liquid or vapor is extremely irritating to the skin. Unlike other chemical agents, there is no immediate visible skin reaction after contact. The delay before initial signs or injury become apparent often results in more extreme damage. The most common local effects are blister formation, brownish discoloration of the skin and slow healing ulcers. Exposure to low concentrations produces lacrimation, rhinorrhea, eye irritation, coughing, dyspnea, choking, wheezing, epistaxis and headache. A brownish discoloration of the tongue and buccal mucosa may result and be accompanied by a characteristic breath odor. Inflammatory lesions of the upper airway, photophobia and blepharospasm are noted at higher levels. Upper and lower respiratory tract: delayed or immediate bronchoconstriction and the development of laryngeal spasm, glottal edema and asthma. With increased parenchymal penetration, there may be associated peribronchiolar abscesses, pulmonary infiltrates consistent with chemical pneumonitis, bronchiolitis obliterans and pulmonary edema. Acute obstructive ventilator impairment may lead to acidosis, measles like rash and subsequent death. It should be noted that more severe respiratory symptoms may be delayed for several hours after the exposure. There is a rare cutaneous manifestation of bromide accumulation is known as bromoderma tuberosum which progresses from red papules to pustules that enlarge and develop into indurated lesions. A mild degree of spermatogenic suppression and impaired reproductive performance following paternal exposure to bromine vapor described in the literature. ANIMAL STUDIES: The mortality of mice exposed to 240 or 750 ppm bromine was dependent on the duration of the study. Rats, mice and rabbits inhaling 0.2 ppm bromine developed disturbances in the functions of their respiratory, nervous and endocrine systems. Rats fed bromine (0.01 mg/kg) for 6 months experienced changes in their conditioned reflexes and several blood indexes. ECOTOXICITY STUDIES: Bromine releases as a consequence of production activities have had serious effects upon vegetation. **PEER REVIEWED**

METABOLISM/ METABOLITES:

ABSORPTION, DISTRIBUTION & EXCRETION:
Bromine vapors enter body by respiratory system, skin and digestive system. It has cumulative properties, being deposited in tissues as bromides.[European Commission/European Chemical Substances Information System (ESIS); IUCLID Dataset, Bromine (7726-95-6) p. 35 (2000). Available from, as of October 2, 2014: http://esis.jrc.ec.europa.eu/] **PEER REVIEWED**

BIOLOGICAL HALF-LIFE:
Biological half-lives of bromine in 15 different organs and tissues of the
rat, in addition to the whole-body half-life, were determined by measuring the radioactive concentration of 82Br-bromide in samples of tissues collected at the time intervals of 12-396 hr from animals that continuously (up to 17 d) received 82Br-labeled bromide in their drinking water. The half-life values, calculated from the experimental data by the method of gradual estimates of the parameters in question with the SPSS statistical program, ranged from 94.3 + or - 14.6 hr in the thyroid gland to 235.0 + or - 88.9 hr in liver. In most of the studied tissues, the biological half-lives of bromine were shorter than in the whole body, in which it equaled 197.8 + or - 22.2 hr. Significant correlation between the values of the steady-state concentration of bromide and of the biological half-life was found for most tissues (except for liver). ...

The biological half-life for bromide through ingestion is 12 to 30 days.[IPCS INCHEM; Poisons Information Monographs, Bromine (PIM 080). Available from, as of June 25, 2007: http://www.inchem.org/pages/pims.html] **PEER REVIEWED**

Bromide has a half-life of about 12 days in the human body.[USEPA/Office of Pesticide Programs; Reregistration Eligibility Decision Document - Bromine p. 6-10. EPA-738-F-93-023 (December 1998) Available from, as of June 7th, 2007: http://www.epa.gov/pesticides/reregistration/status.htm] **PEER REVIEWED**

10.5 days and in an average clearance of 0.68 mL/min.[Seiler, H.G., H. Sigel and A. Sigel (eds.). Handbook on the Toxicity of Inorganic Compounds. New York, NY: Marcel Dekker, Inc. 1988., p. 147] **PEER REVIEWED**

**MECHANISM OF ACTION:**

Due to its potent oxidizing action, bromine liberates nascent oxygen or oxygen free radicals from the water present in mucous membranes. Nascent oxygen is a potent oxidizer, capable of producing tissue damage. The extent of the damage is dependent on the dose of bromine and the availability of water to react with it. In addition, the formation of hydrobromic and bromic acids will result in secondary irritation during the reaction.[IPCS INCHEM; Poisons Information Monographs, Bromine (PIM 080). Available from, as of June 25, 2007: http://www.inchem.org/pages/pims.html] **PEER REVIEWED**

**REPORTED FATAL DOSE:**

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ENVIRONMENTAL FATE/EXPOSURE SUMMARY:

Bromine's production and use in the manufacture of flame retardants, oil well drilling fluids, pesticides, pharmaceuticals and other compounds may result in its release to the environment through various waste streams; its use as a fumigant for stored grains and other produce and use as water disinfectant in hot tubs, swimming pools and whirlpools will result in its direct release to the environment. If released to air, a vapor pressure of 212 mm Hg at 25 deg C indicates bromine will exist solely as a vapor in the atmosphere. Vapor-phase bromine in the atmosphere (BR2) will react with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 8.6 hours. Bromine absorbs at wavelengths > 290 nm and, therefore, may be susceptible to direct photolysis by sunlight. If released to soil, volatilization from moist soil surfaces is expected to be an important fate process based upon a Henry's Law constant of 1.32X10^-3 atm-cu m/mole. Bromine is expected to volatilize rapidly from dry soil surfaces based upon its vapor pressure. If released into water, volatilization from water surfaces is expected to be an important fate process based upon this compound's Henry's Law constant. When bromine dissolves in water, it partially disproportionates into HOBr (hypobromous acid). Above pH 3, the fraction present as Br2 decreases and HOBr is formed; between pH 6 and pH 8, most of the bromine is present as HOBr. Bromine will slowly be reduced to bromide by natural oxidizable materials in water and soil. Occupational exposure to bromine may occur through inhalation and dermal contact with this compound at workplaces where bromine is produced or used. (SRC) **PEER REVIEWED**

PROBABLE ROUTES OF HUMAN EXPOSURE:

According to the 2012 TSCA Inventory Update Reporting data, the number of persons reasonably likely to be exposed in the industrial manufacturing, processing, and use of bromine is 100 to 999; the data may be greatly underestimated.(1) [(1) US EPA; Chemical Data Reporting (CDR). Non-confidential 2012 Chemical Data Reporting information on chemical production and use in the United States. Available from, as of Oct 14, 2014: http://www.epa.gov/cdr/pubs/guidance/cdr_factsheets.html] **PEER REVIEWED**

NIOSH (NOES Survey 1981-1983) has statistically estimated that 62,214 workers (10,780 of these are female) are potentially exposed to bromine in the US(1). [(1) NIOSH; NOES. National Occupational Exposure Survey conducted from 1981-1983. Estimated numbers of employees potentially exposed to specific agents by 2-digit standard industrial classification (SIC). Available from, as of Oct 10, 2014: http://www.cdc.gov/noes/] **PEER REVIEWED**

NATURAL POLLUTION SOURCES:

ARTIFICIAL POLLUTION SOURCES:
Bromine's production and use in the manufacture of flame retardants, oil well drilling fluids, pesticides, pharmaceuticals and other compounds(1,2) may result in its release to the environment through various waste streams(SRC); its use as a fumigant for stored grains and other produce(2) and use as water disinfectant in hot tubs, swimming pools and whirlpools(1,2) will result in its direct release to the environment(SRC).

ENVIRONMENTAL FATE:

TERRESTRIAL FATE: Volatilization of bromine from moist soil surfaces is expected to be an important fate process(SRC) given an estimated Henry's Law constant of 1.32X10^-3 atm-cu m/mole(1). Bromine is expected to volatilize from dry soil surfaces(SRC) based upon a vapor pressure of 212 mm Hg at 25 deg C(2). Bromine is reportedly vaporized rapidly at room temperature(3). Bromine will slowly be reduced to bromide by natural oxidizable materials in water and soil(4).

AQUATIC FATE: Volatilization of bromine from water surfaces is expected(1) based upon a Henry's Law constant of 1.32X10^-3 atm-cu m/mole(2). Using this Henry's Law constant and an estimation method(1), volatilization half-lives for a model river and model lake are 4.5 hours and 5 days, respectively(SRC). When bromine dissolves in water, it partially disproportionates into HOBr (hypobromous acid) and HBr(3). Above pH 3, the fraction present as Br2 decreases and HOBr is formed(4); between pH 6 and pH 8, most of the bromine is present as HOBr(4). Bromine will slowly be reduced to bromide by natural oxidizable materials in water and soil(4). Bromine absorbs at wavelengths > 290 nm(5) and, therefore, may be susceptible to direct photolysis on water surfaces exposed to sunlight(SRC).

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ATMOSPHERIC FATE: According to a model of gas/particle partitioning of semivolatile organic compounds in the atmosphere(1), bromine, which has a vapor pressure of 212 mm Hg at 25 deg C(2), is expected to exist solely as a vapor in the ambient atmosphere. Vapor-phase bromine is degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals(SRC); the half-life for this reaction in air is estimated to be 8.6 hours(SRC), calculated from its rate constant of 4.5X10-11 cu cm/molecule-sec at 25 deg C(3). The reaction of bromine with photochemically-produced hydroxyl radicals yields the bromide radical and HOBr(3). Bromine absorbs at wavelengths > 290 nm(4) and, therefore, may be susceptible to direct photolysis by sunlight(SRC).


ENVIRONMENTAL BIODEGRADATION:

ENVIRONMENTAL ABIOTIC DEGRADATION:
The rate constant for the vapor-phase reaction of bromine with photochemically-produced hydroxyl radicals has been measured as 4.5X10-11 cu cm/molecule-sec at 25 deg C(1). This corresponds to an atmospheric half-life of about 8.6 hours at an atmospheric concentration of 5X10+5 hydroxyl radicals per cu cm(2). The reaction of bromine with photochemically-produced hydroxyl radicals yields the bromide radical and HOBr(1). In the presence of moisture and sunlight, bromine has a short life-time and is transformed into hydrobromic acid and oxygen(3). In water below pH 3, bromine is present almost entirely as the molecular Br2(3); above pH 3, the fraction present as Br2 decreases and HOBr is formed(3); between pH 6 and pH 8, most of the bromine is present as HOBr(3). Bromine gas absorbs at wavelengths > 290 nm(4) and, therefore, may be susceptible to direct photolysis by sunlight(SRC).

VOLATILIZATION FROM WATER/SOIL:
The Henry's Law constant for bromine is 1.32X10-3 atm-cu m/mole(1). This Henry's Law constant indicates that bromine is expected to volatilize rapidly from water surfaces(2). Based on this Henry's Law constant, the volatilization half-life from a model river (1 m deep, flowing 1 m/sec, wind velocity of 3 m/sec)(2) is estimated as 4.5 hours(SRC). The volatilization half-life from a model lake (1 m deep, flowing 0.05 m/sec, wind velocity of 0.5 m/sec)(2) is estimated as 5 days(SRC). Bromine's Henry's Law constant indicates that volatilization from moist soil surfaces may occur(SRC). Bromine is expected to volatilize from dry soil surfaces(SRC) based upon a vapor pressure of 212 mm Hg at 25 deg C(3). Bromine is reported to vaporize rapidly at room temperature(4).[(1) Sander R; Compilation of Henry's Law Constants for Inorganic and Organic Species of Potential Importance in Environmental Chemistry. Available from, as of Oct 10, 2014: http://www.henrys-law.org/henry.pdf (2) Lyman WJ et al; Handbook of Chemical Property Estimation Methods. Washington, DC: Amer Chem Soc pp. 15-1 to 15-29 (1990) (3) Daubert TE, Danner RP; Physical and Thermodynamic Properties of Pure Chemicals Data Compilation. Washington, DC: Taylor and Francis (1989) (4) O'Neil MJ, ed; The Merck Index. 15th ed., Cambridge, UK: Royal Society of Chemistry, p. 246 (2013)] **PEER REVIEWED**

SKIN, EYE AND RESPIRATORY IRRITATIONS:

Irritating concn 2.10 mg/cu m[Ruth JH; Am Ind Hyg Assoc J 47: A-142-51 (1986)] **PEER REVIEWED**

Bromine is a lacrimator at concentrations below 6.5 mg/cu m.[European Commission/European Chemical Substances Information System (ESIS); IUCLID Dataset, Bromine (7726-95-6) p. 35 (2000). Available from, as of October 2, 2014: http://esis.jrc.ec.europa.eu/] **PEER REVIEWED**

A toxic vapor, very irritating to eyes and respiratory tract ... respiratory damage occurs at 10 ppm.[European Commission/European Chemical Substances Information System (ESIS); IUCLID Dataset, Bromine (7726-95-6) p. 35 (2000). Available from, as of October 2, 2014: http://esis.jrc.ec.europa.eu/] **PEER REVIEWED**