Cyanogen bromide

sc-203011

Material Safety Data Sheet

Hazard Alert Code Key: EXTREME HIGH MODERATE LOW

Section 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

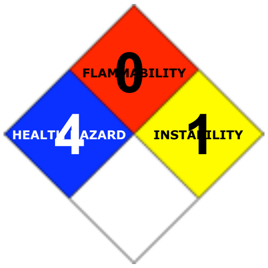
PRODUCT NAME

Cyanogen bromide

STATEMENT OF HAZARDOUS NATURE

CONSIDERED A HAZARDOUS SUBSTANCE ACCORDING TO OSHA 29 CFR 1910.1200.

NFPA



SUPPLIER

Company: Santa Cruz Biotechnology, Inc.
Address:
2145 Delaware Ave
Santa Cruz, CA 95060
Telephone: 800.457.3801 or 831.457.3800
Emergency Tel: CHEMWATCH: From within the US and Canada: 877-715-9305
Emergency Tel: From outside the US and Canada: +800 2436 2255 (1-800-CHEMCALL) or call +613 9573 3112

PRODUCT USE

Organic synthesis, parasiticide, fumigating compositions, rat exterminants, cyaniding reagent in gold extraction process. For selective peptide cleavage, e.g. methionine, and for use in protein immobilisation procedures.

SYNONYMS

Br-C-N, BrCN, "bromine cyanide", bromocyan, bromocyanide, bromocyanogen, campilit, cyanobromide, "cyanogen monobromide"

Section 2 - HAZARDS IDENTIFICATION

CANADIAN WHMIS SYMBOLS

EMERGENCY OVERVIEW

RISK

Contact with acids liberates very toxic gas.
Causes burns.
Risk of serious damage to eyes.
Very toxic by inhalation, in contact with skin and if swallowed.
May cause long-term adverse effects in the environment.

Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

POTENTIAL HEALTH EFFECTS

ACUTE HEALTH EFFECTS

SWALLOWED

- Severely toxic effects may result from the accidental ingestion of the material; animal experiments indicate that ingestion of less than 5 gram may be fatal or may produce serious damage to the health of the individual.
- The material can produce chemical burns within the oral cavity and gastrointestinal tract following ingestion.
- Cyanide poisoning can cause increased saliva output, nausea without vomiting, anxiety, confusion, vertigo, dizziness, stiffness of the lower jaw, convulsions, spasm, paralysis, coma and irregular heartbeat, and stimulation of breathing followed by failure. Often the skin becomes cyanosed (blue-gray), and this is often delayed. Doses which are not lethal are eventually excreted in the urine.
- Nitrile poisoning exhibits similar symptoms to poisoning due to hydrogen cyanide. The substances irritate the eyes and skin, and are absorbed quickly and completely through the skin. The use of the term "organic nitriles" should be discouraged.

EYE

- The material can produce chemical burns to the eye following direct contact. Vapors or mists may be extremely irritating.
- If applied to the eyes, this material causes severe eye damage.

SKIN

- Skin contact with the material may produce severely toxic effects; systemic effects may result following absorption and these may be fatal.
- The material can produce chemical burns following direct contactwith the skin.
- Open cuts, abraded or irritated skin should not be exposed to this material.
- Entry into the blood-stream, through, for example, cuts, abrasions or lesions, may produce systemic injury with harmful effects. Examine the skin prior to the use of the material and ensure that any external damage is suitably protected.

INHALED

- Inhalation of vapors, aerosols (mists, fumes) or dusts, generated by the material during the course of normal handling, may produce severely toxic effects; these may be fatal.
- Exposure by inhalation at high concentrations of cyanogen bromide may cause death. However, as cyanogen bromide is extremely irritating it is unlikely that anyone would voluntarily remain in areas with high enough concentrations to exert a cyanide effect.

Inhalation/ingestion exposure symptoms include weakness, headache, giddiness, dizziness, confusion, anxiety, nausea and vomiting. In severe cases breathing is rapid and deep then becomes slow and gasping; an irregular heartbeat and tightness in the chest may be experienced.

The skin may become pink or red. Fluid may fill the lungs and interfere with breathing. Unconsciousness and death may quickly follow depending on degree of exposure.

- The intensity and time of exposure to hydrogen cyanide determines effects, symptoms. Short term inhalation of 20 to 40 ppm hydrogen cyanide may result in slight symptoms. Higher concentrations can cause death within minutes or hours; a concentration of 270 ppm can be fatal in one minute. Acute exposure to cyanides can cause death by cyanosis, asphyxia. At very low doses, symptoms of hydrogen cyanide exposure may be weakness, headaches, confusion, giddiness, dizziness, confusion, anxiety, nausea and vomiting. Normal blood pressure with rapid pulse is usual in mild cases. The respiratory rate varies with the intensity of exposure: rapid with mild exposure, or slow and gasping with severe exposure. Symptoms of mild exposure to hydrogen cyanide are completely reversed when exposure ceases.

In severe cases, breathing is rapid and deep, then becomes slow and gasping. The victim may feel an irregular heartbeat and tightness in the chest. The skin appears bright pink or red. Fluid may fill the lungs and interfere with breathing. Unconsciousness, convulsions and death can quickly follow depending on the degree of exposure. Massive exposures may produce sudden collapse and death. concentration of 270 If death does not result, recovery is usually complete. There have however been a few reports of after-effects. These are similar to those seen in people deprived of oxygen, e.g. near-drowning victims.

- The material can cause respiratory irritation in some persons. The body's response to such irritation can cause further lung damage.

CHRONIC HEALTH EFFECTS

- Limited evidence suggests that repeated or long-term occupational exposure may produce cumulative health effects involving organs or biochemical systems.

There is some evidence that human exposure to the material may result in developmental toxicity. This evidence is based on animal studies where effects have been observed in the absence of marked maternal toxicity, or at around the same dose levels as other toxic effects but which are not secondary non-specific consequences of the other toxic effects.

Long term exposure to high dust concentrations may cause changes in lung function i.e. pneumoconiosis; caused by particles less than 0.5 micron penetrating and remaining in the lung. Prime symptom is breathlessness; lung shadows show on X-ray.

Chronic intoxication with ionic bromides, historically, has resulted from medical use of bromides but not from environmental or occupational exposure; depression, hallucinosis, and schizophreniform psychosis can be seen in the absence of other signs of intoxication. Bromides may also induce sedation, irritability, agitation, delirium, memory loss, confusion, disorientation, forgetfulness (aphasias), dysarthria, weakness, fatigue, vertigo, stupor, coma, decreased appetite, nausea and vomiting, diarrhoea, hallucinations, an acne like rash on the face, legs and trunk, known as bronchoderma (seen in 25-30% of case involving bromide ion), and a profuse discharge from the nostrils (coryza). Ataxia and generalised hyperreflexia have also been observed. Correlation of neurologic symptoms with blood levels of bromide is inexact. The use of substances such as brompheniramine, as antihistamines, largely reflect current day usage of bromides; ionic bromides have been largely withdrawn from therapeutic use due to their toxicity. Several cases of foetal abnormalities have been described in mothers who took large doses of bromides during pregnancy.

Chronic exposure to cyanides and certain nitriles may result in interference to iodine uptake by thyroid gland and its consequent enlargement. This occurs following metabolic conversion of the cyanide moiety to thiocyanate. Thyroid insufficiency may also occur as a result of metabolic conversion of cyanides to the corresponding thiocyanate. Exposure to small amounts of cyanide compounds over long periods are reported to cause loss of appetite, headache, weakness, nausea, dizziness, abdominal pain, changes in taste and smell, muscle cramps, weight loss, flushing of the face, persistent runny nose and irritation of the upper respiratory tract and eyes. These symptoms are not specific to cyanide exposure and therefore the existence of a chronic cyanide toxicity remains speculative. Repeated minor contact with cyanides produce a characteristic rash with itching, papules (small, superficial raised spots on the skin) and possible sensitization. Concerns have been expressed that low-level, long term exposures may result in damage to the nerves of the eye.

Repeated or prolonged exposure to acids may result in the erosion of teeth, swelling and or ulceration of mouth lining. Irritation of airways to lung, with cough, and inflammation of lung tissue often occurs. Chronic exposure may inflame the skin or conjunctiva.

Section 3 - COMPOSITION / INFORMATION ON INGREDIENTS

HAZARD RATINGS

		Min Max
Flammability:	1	
Toxicity:	4	
Body Contact:	4	
Reactivity:	1	
Chronic:	3	

Min/Nil=0
Low=1
Moderate=2
High=3
Extreme=4

NAME	CAS RN	%
cyanogen bromide	506-68-3	>98
undergoes slow hydrolysis to give		
hydrogen cyanide	74-90-8	
hydrogen bromide	10035-10-6	

Section 4 - FIRST AID MEASURES

SWALLOWED

■ IMPORTANT: ESTABLISH A FIRST AID PLAN BEFORE WORKING WITH CYANIDES. ANTIDOTES SHOULD BE AVAILABLE ON SITE.

- Prompt response in an emergency is vital.
- All workers are to be trained and refresher trained in procedures.
- Rescuers might need the protection of breathing apparatus where there is the potential of exposure to airborne cyanide.
- Use the buddy system and avoid becoming a casualty.

In all cases of cyanide exposure get medical help urgently after administering first aid. For cyanide poisonings by any route:

- Contact Poisons Advisory Center or a doctor.
- Seek immediate medical attention.
- Place casualty in coma position.
- Give oxygen when available.
- Consider external cardiac compression, mechanical resuscitation and use of antidote kit.

If breathing stops mouth-to-mouth resuscitation (also called expired air resuscitation - EAR) may be given only as a last resort. Should such resort prove necessary, first wash the casualty's mouth and lips. A first aid attendant giving EAR must not inhale the expired air of the casualty. US Practice as employed by DuPont:- FIRST AID Swallowed/ Inhaled /Skin Contact

- If no symptoms, no treatment is necessary; decontaminate patient.
- If conscious but with symptoms present (nausea, shortness of breath, dizziness) give oxygen.
- If consciousness is impaired (slurred speech, drowsiness) give oxygen and amyl nitrite.
- If unconscious but breathing, give oxygen and amyl nitrite by means of a respirator. To give amyl nitrite, break an ampoule in a cloth and insert into lip of mask for 15 seconds, then take away for 15 seconds. Repeat 5-6 times.

First Aid Supplies for cyanide poisoning should be conveniently placed throughout cyanide areas and should be IMMEDIATELY accessible at all times. They should be routinely inspected (typically daily) by people who would use them in an emergency. The total numbers of any item listed below should be adequate to handle the largest number of exposure cases that can reasonably be anticipated, taking into account that some supplies may be wasted, destroyed or inaccessible during an emergency. Oxygen Resuscitators - The Flynn Series III Model from O-Two Systems has been found satisfactory, being lightweight, rugged and easy to use. Amyl Nitrite Ampoules - One box of one dozen ampoules per station is usually satisfactory. Stations should be located throughout the cyanide area. CAUTION: Amyl nitrite is not stable and must be replaced every 1 to 2 years. Store in the original dated box away from heat. (can be stored with the resuscitator). Avoid storage on vehicles where cabin temperatures can reach 60 deg. C. Storage in high temperature climates may require replacement before the expiry date on the box. Also avoid excessive cold storage which may limit the vapor pressure and reduce its evaporating property. Kits and amyl nitrite should be accessible, but secured against tampering or theft (an increase in the use of nitrite "poppers", as aphrodisiacs, introduces substance abuse concerns). A set of cyanide first aid instructions should be located at each amyl nitrite storage location. Workers should be fully trained since in real emergency situations there will be insufficient time to "read the book". Notes on the use of amyl nitrite:-

- AN is highly volatile and flammable - do not smoke or use around a source of ignition.
- If treating patient in a windy or draughty area provide some shelter or protection (shirt, wall, drum, cupped hand etc.) to prevent amyl nitrite vapor from being blown away. Keep ampoule upwind from the nose , the objective is to get amyl nitrite into the patient's lungs.
- Rescuers should avoid AN inhalation to avoid becoming dizzy and losing competence.
- Lay the patient down. Since AN dilates blood vessels and lowers blood pressure, lying down will help keep the patient conscious.
- DO NOT overuse - excessive use might put the patient into shock.
- Vasodilatory effects of amyl nitrate may promote fatal cardiac arrhythmias (particularly if the patient is not really poisoned by cyanide).
- the role of amyl nitrate as a competitive inducer of methemoglobin in the blood stream is highly variable and, alone, may produce levels of methemoglobin as a low as 5% only.

Experience at DuPont plants has not shown any serious after-effects from treatment with amyl nitrite.

EYE

■ If this product comes in contact with the eyes:

- Immediately hold eyelids apart and flush the eye continuously with running water.
- Ensure complete irrigation of the eye by keeping eyelids apart and away from eye and moving the eyelids by occasionally lifting the upper and lower lids.
- Continue flushing until advised to stop by the Poisons Information Center or a doctor, or for at least 15 minutes.
- Transport to hospital or doctor without delay.
- Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.

SKIN

■ If skin or hair contact occurs:

- Immediately flush body and clothes with large amounts of water, using safety shower if available.
- Quickly remove all contaminated clothing, including footwear.
- Wash skin and hair with running water. Continue flushing with water until advised to stop by the Poisons Information Center.
- Transport to hospital, or doctor.

INHALED

■

- If fumes or combustion products are inhaled remove from contaminated area.
- Lay patient down. Keep warm and rested.
- Prostheses such as false teeth, which may block airway, should be removed, where possible, prior to initiating first aid procedures.
- Apply artificial respiration if not breathing, preferably with a demand valve resuscitator, bag-valve mask device, or pocket mask as trained. Perform CPR if necessary.
- Transport to hospital, or doctor, without delay.

Inhalation of vapors or aerosols (mists, fumes) may cause lung edema. Corrosive substances may cause lung damage (e.g. lung edema, fluid in the lungs). As this reaction may be delayed up to 24 hours after exposure, affected individuals need complete rest (preferably in semi-recumbent posture) and must be kept under medical observation even if no symptoms are (yet) manifested. Before any such manifestation, the administration of a spray containing a dexamethasone derivative or beclomethasone derivative may be considered. This must definitely be left to a doctor or person authorized by him/her. (ICSC13719).

NOTES TO PHYSICIAN

■

- Signs symptoms of acute cyanide poisoning reflect cellular hypoxia and are often non-specific.
- Cyanosis may be a late finding.
- A bradycardia, hypertensive and tachypneic patient suggests poisoning especially if CNS and c ardiovascular depression subsequently occurs.
- Immediate attention should be directed towards assisted ventilation, administration of 100% oxygen, insertion of intravenous lines and institution of cardiac monitoring.
- Obtain an arterial blood gas immediately and correct any severe metabolic acidosis (pH below 7.15).
- Mildly symptomatic patients generally require supportive care alone. Nitrites should not be given indiscriminately - in all cases of

moderate to severe poisoning, they should be given in conjunction with thiosulfate. As a temporizing measure supply amyl nitrite perles (0.2ml inhaled 30 seconds every minute) until intravenous lines for sodium nitrite are established. 10 ml of a 3% solution is administered over 4 minutes to produce 20% methemoglobin in adults. Follow directly with 50 ml of 25% sodium thiosulfate, at the same rate, IV. If symptoms reappear or persist within 1/2-1 hour, repeat nitrite and thiosulfate at 50% of initial dose. As the mode of action involves the metabolic conversion of the thiosulfate to thiocyanate, renal failure may enhance thiocyanate toxicity.

- Methylene blue is not an antidote. [Ellenhorn and Barceloux: Medical Toxicology]

If amyl nitrite intervention is employed then Medical Treatment Kits should contain the following:

- One box containing one dozen amyl nitrite ampoules
- Two sterile ampoules of sodium nitrite solution (10 mL of a 3% solution in each)
- Two sterile ampoules of sodium thiosulfate solution (50 mL of a 25% solution in each)
- One 10 mL sterile syringe. One 50 mL sterile syringe. Two sterile intravenous needles. One tourniquet.
- One dozen gauze pads.
- Latex gloves
- A "Biohazard" bag for disposal of bloody/contaminated equipment.
- A set of cyanide instructions on first aid and medical treatment.

- Notes on the use of amyl nitrite:-

- AN is highly volatile and flammable - do not smoke or use around a source of ignition.
- If treating patient in a windy or draughty area provide some shelter or protection (shirt, wall, drum, cupped hand etc.) to prevent amyl nitrite vapor from being blown away. Keep ampoule upwind from the nose, the objective is to get amyl nitrite into the patient's lungs.
- Rescuers should avoid AN inhalation to avoid becoming dizzy and losing competence.
- Lay the patient down. Since AN dilates blood vessels and lowers blood pressure, lying down will help keep patient conscious.
- DO NOT overuse - excessive use might put the patient into shock. Experience at DuPont plants has not shown any serious after-effects from treatment with amyl nitrite.

ADDITIONAL NOTES:

- Major medical treatment procedures may vary e.g. US (FDA method as recommended by DuPont) uses amyl nitrite as a methemoglobin generator, followed by treatment with sodium nitrite and then sodium thiosulfate.

MODES OF ACTION: Amyl nitrite (AN) reacts with hemoglobin (HB) to form about 5% methemoglobin (MHB). Sodium nitrite (NaNO2) reacts with hemoglobin to form approximately 20-30% methemoglobin. Methemoglobin attracts cyanide ions (CN) from tissue and binds with them to become cyanmethemoglobin (CNMHB). Sodium thiosulfate (Na2S2O3) converts cyanmethemoglobin to thiocyanate (HSCN) which is excreted by the kidneys. i.e. AN + HB = MHB NaNO2 + HB = MHB CN + MHB = CNMHB Na2S2O3 + CNMHB + O2 = HSCN

- The administration of the antidote salts is intravenous in normal saline, Ringers lactate or other available IV fluid.

Section 5 - FIRE FIGHTING MEASURES

Vapor Pressure (mmHg):	99.758 @ 22.6 C
Upper Explosive Limit (%):	Not Available
Specific Gravity (water=1):	2.015 @ 20/4 C
Lower Explosive Limit (%):	Not Available

EXTINGUISHING MEDIA

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- Alcohol stable foam.
- Foam.
- Dry chemical powder.
- BCF (where regulations permit).
- Carbon dioxide.
- Water spray or fog - Large fires only.

FIRE FIGHTING

■

- Alert Emergency Responders and tell them location and nature of hazard.
- Wear full body protective clothing with breathing apparatus.
- Prevent, by any means available, spillage from entering drains or water course.
- Use fire fighting procedures suitable for surrounding area.
- DO NOT approach containers suspected to be hot.
- Cool fire exposed containers with water spray from a protected location.
- If safe to do so, remove containers from path of fire.

- Equipment should be thoroughly decontaminated after use.

GENERAL FIRE HAZARDS/HAZARDOUS COMBUSTIBLE PRODUCTS

■ Combustion products include: carbon monoxide (CO), carbon dioxide (CO2), hydrogen bromide, nitrogen oxides (NOx), other pyrolysis products typical of burning organic material.
May emit poisonous fumes.

- Solid which exhibits difficult combustion or is difficult to ignite.
- Avoid generating dust, particularly clouds of dust in a confined or unventilated space as dusts may form an explosive mixture with air, and any source of ignition, i.e. flame or spark, will cause fire or explosion. Dust clouds generated by the fine grinding of the solid are a particular hazard; accumulations of fine dust may burn rapidly and fiercely if ignited.
- Dry dust can be charged electrostatically by turbulence, pneumatic transport, pouring, in exhaust ducts and during transport.
- Build-up of electrostatic charge may be prevented by bonding and grounding.
- Powder handling equipment such as dust collectors, dryers and mills may require additional protection measures such as explosion venting.

FIRE INCOMPATIBILITY

■ Avoid contamination with oxidizing agents i.e. nitrates, oxidizing acids,chlorine bleaches, pool chlorine etc. as ignition may result.

PERSONAL PROTECTION

Glasses:
Full face- shield.
Gloves:
Respirator:
Type B-P Filter of sufficient capacity

Section 6 - ACCIDENTAL RELEASE MEASURES

MINOR SPILLS

■ Environmental hazard - contain spillage.

- Clean up waste regularly and abnormal spills immediately.
- Avoid breathing dust and contact with skin and eyes.
- Wear protective clothing, gloves, safety glasses and dust respirator.
- Use dry clean up procedures and avoid generating dust.
- Vacuum up or sweep up. NOTE: Vacuum cleaner must be fitted with an exhaust micro filter (HEPA type) (consider explosion-proof machines designed to be grounded during storage and use).
- Dampen with water to prevent dusting before sweeping.
- Place in suitable containers for disposal.

MAJOR SPILLS

■ Environmental hazard - contain spillage.

- Clear area of personnel and move upwind.
- Alert Emergency Responders and tell them location and nature of hazard.
- Wear full body protective clothing with breathing apparatus.
- Prevent, by any means available, spillage from entering drains or water course.
- Consider evacuation.
- Stop leak if safe to do so.
- Contain spill with sand, earth or vermiculite.
- Collect recoverable product into labeled containers for recycling.
- Neutralize/decontaminate residue.
- Collect solid residues and seal in labeled drums for disposal.
- Wash area and prevent runoff into drains.
- After clean up operations, decontaminate and launder all protective clothing and equipment before storing and re-using.
- If contamination of drains or waterways occurs, advise emergency services.

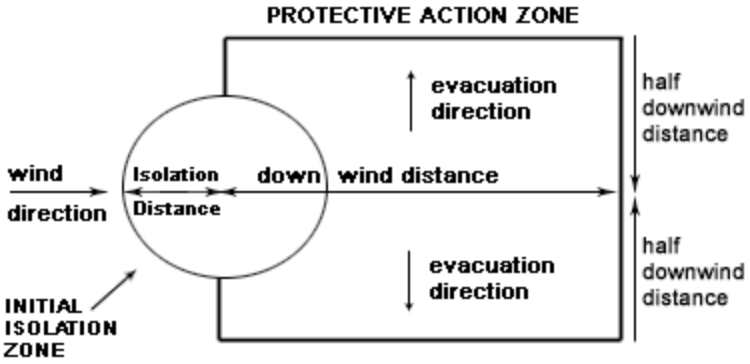
PROTECTIVE ACTIONS FOR SPILL

Cyanogen bromide

sc-203011

Material Safety Data Sheet

Hazard Alert Code Key:	EXTREME	HIGH	MODERATE	LOW



From IERG (Canada/Australia)	
Isolation Distance	25 meters
Downwind Protection Distance	250 meters

FOOTNOTES

1 PROTECTIVE ACTION ZONE is defined as the area in which people are at risk of harmful exposure. This zone assumes that random changes in wind direction confines the vapour plume to an area within 30 degrees on either side of the predominant wind direction, resulting in a crosswind protective action distance equal to the downwind protective action distance.
2 PROTECTIVE ACTIONS should be initiated to the extent possible, beginning with those closest to the spill and working away from the site in the downwind direction. Within the protective action zone a level of vapour concentration may exist resulting in nearly all unprotected persons becoming incapacitated and unable to take protective action and/or incurring serious or irreversible health effects.
3 INITIAL ISOLATION ZONE is determined as an area, including upwind of the incident, within which a high probability of localised wind reversal may expose nearly all persons without appropriate protection to life-threatening concentrations of the material.
4 SMALL SPILLS involve a leaking package of 200 litres (55 US gallons) or less, such as a drum (jerrican or box with inner containers). Larger packages leaking less than 200 litres and compressed gas leaking from a small cylinder are also considered "small spills". LARGE SPILLS involve many small leaking packages or a leaking package of greater than 200 litres, such as a cargo tank, portable tank or a "one-tonne" compressed gas cylinder.
5 Guide 157 is taken from the US DOT emergency response guide book.
6 IERG information is derived from CANUTEC - Transport Canada.

ACUTE EXPOSURE GUIDELINE LEVELS (AEGL) (in ppm)

hydrogen cyanide					
AEGL Type	10 min	30 min	60 min	4 hr	8 hr
AEGL 1	2.5	2.5	2	1.3	GALSYN~
AEGL 2	17	10	7.1	3.5	GALSYN~
AEGL 3	27	21	15	8.6	GALSYN~

AEGL 1: The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic nonsensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.
AEGL 2: The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.
AEGL 3: The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.

Section 7 - HANDLING AND STORAGE

PROCEDURE FOR HANDLING

■

- Avoid all personal contact, including inhalation.

- Wear protective clothing when risk of exposure occurs.
- Use in a well-ventilated area.
- Prevent concentration in hollows and sumps.
- DO NOT enter confined spaces until atmosphere has been checked.
- DO NOT allow material to contact humans, exposed food or food utensils.
- Avoid contact with incompatible materials.
- When handling, DO NOT eat, drink or smoke.
- Keep containers securely sealed when not in use.
- Avoid physical damage to containers.
- Always wash hands with soap and water after handling.
- Work clothes should be laundered separately.
- Launder contaminated clothing before re-use.
- Use good occupational work practice.
- Observe manufacturer's storing and handling recommendations.
- Atmosphere should be regularly checked against established exposure standards to ensure safe working conditions are maintained.

Empty containers may contain residual dust which has the potential to accumulate following settling. Such dusts may explode in the presence of an appropriate ignition source.

- Do NOT cut, drill, grind or weld such containers.
- In addition ensure such activity is not performed near full, partially empty or empty containers without appropriate workplace safety authorisation or permit.

RECOMMENDED STORAGE METHODS

■ Glass container.

- Lined metal can, Lined metal pail/drum
- Plastic pail
- Polyliner drum
- Packing as recommended by manufacturer.
- Check all containers are clearly labeled and free from leaks.

For low viscosity materials

- Drums and jerricans must be of the non-removable head type.
- Where a can is to be used as an inner package, the can must have a screwed enclosure.

For materials with a viscosity of at least 2680 cSt. (23 deg. C) and solids (between 15 C deg. and 40 deg C.):

- Removable head packaging;
- Cans with friction closures and
- low pressure tubes and cartridges may be used.

- Where combination packages are used, and the inner packages are of glass, there must be sufficient inert cushioning material in contact with inner and outer packages * . - In addition, where inner packagings are glass and contain liquids of packing group I and II there must be sufficient inert absorbent to absorb any spillage *. - * unless the outer packaging is a close fitting molded plastic box and the substances are not incompatible with the plastic. All inner and sole packagings for substances that have been assigned to Packaging Groups I or II on the basis of inhalation toxicity criteria, must be hermetically sealed.

STORAGE REQUIREMENTS

■

- Store in original containers.
- Keep containers securely sealed.
- Store in a cool, dry, well-ventilated area.
- Store away from incompatible materials and foodstuff containers.
- Protect containers against physical damage and check regularly for leaks.
- Observe manufacturer's storing and handling recommendations.

SAFE STORAGE WITH OTHER CLASSIFIED CHEMICALS

X X + X X +

X: Must not be stored together

Cyanogen bromide

sc-203011

Material Safety Data Sheet

Hazard Alert Code Key: EXTREME | HIGH | MODERATE | LOW

O: May be stored together with specific preventions
+: May be stored together

Section 8 - EXPOSURE CONTROLS / PERSONAL PROTECTION

EXPOSURE CONTROLS

Source	Material	TWA ppm	TWA mg/m³	STEL ppm	STEL mg/m³	Peak ppm	Peak mg/m³	TWA F/CC	Notes
US - Idaho - Limits for Air Contaminants	cyanogen bromide (Cyanides (as CN))		5						
US - California Permissible Exposure Limits for Chemical Contaminants	cyanogen bromide (Cyanide, as CN)		5						
US - Minnesota Permissible Exposure Limits (PELs)	cyanogen bromide (Cyanides (as CN))			5					
US - Vermont Permissible Exposure Limits Table Z-1-A Final Rule Limits for Air Contaminants	cyanogen bromide (Cyanides (as CN))		5						
US - Vermont Permissible Exposure Limits Table Z-1-A Transitional Limits for Air Contaminants	cyanogen bromide (Cyanides (as CN))		5						
US - Tennessee Occupational Exposure Limits - Limits For Air Contaminants	cyanogen bromide (Cyanides (as CN))		5						
US OSHA Permissible Exposure Levels (PELs) - Table Z1	cyanogen bromide (Cyanides (as CN))		5						
US - Alaska Limits for Air Contaminants	cyanogen bromide (Cyanides (as CN))		5						
US - Hawaii Air Contaminant Limits	cyanogen bromide (Cyanides (as CN))		5						(CAS (Varies with compound))
US - Washington Permissible exposure limits of air contaminants	cyanogen bromide (Cyanide (as CN))		5		10				
Canada - Quebec Permissible Exposure Values for Airborne Contaminants (English)	cyanogen bromide (Cyanides (as CN))					10	11		
US - Wyoming Toxic and Hazardous Substances Table Z1 Limits for Air Contaminants	cyanogen bromide (Cyanides (as CN))		5						
US - Oregon Permissible Exposure Limits (Z1)	cyanogen bromide (Cyanides (as CN))		5						
Canada - British Columbia Occupational Exposure Limits	hydrogen cyanide (Hydrogen cyanide, as CN)					4.7			Skin

Canada - Ontario Occupational Exposure Limits	hydrogen cyanide (Hydrogen cyanide and Cyanide salts, as CN Hydrogen cyanide)					4.7		Skin
US - Minnesota Permissible Exposure Limits (PELs)	hydrogen cyanide (Hydrogen cyanide)			4.7	5			
US ACGIH Threshold Limit Values (TLV)	hydrogen cyanide (Hydrogen cyanide)					4.7		Measured as CN. TLV Basis: upper respiratory tract irritation; headache; nausea; thyroid effects
US NIOSH Recommended Exposure Limits (RELs)	hydrogen cyanide (Hydrogen cyanide)			4.7	5			
Canada - Alberta Occupational Exposure Limits	hydrogen cyanide (Cyanide and Cyanide salts and hydrogen cyanide as CN: Hydrogen cyanide)					4.7	5.2	
US - Tennessee Occupational Exposure Limits - Limits For Air Contaminants	hydrogen cyanide (Hydrogen cyanide)			4.7	5			
US - Vermont Permissible Exposure Limits Table Z-1-A Transitional Limits for Air Contaminants	hydrogen cyanide (Hydrogen cyanide)	10	11					
US - Vermont Permissible Exposure Limits Table Z-1-A Final Rule Limits for Air Contaminants	hydrogen cyanide (Hydrogen cyanide)			4.7	5			
US - California Permissible Exposure Limits for Chemical Contaminants	hydrogen cyanide (Hydrogen cyanide)					4.7	5	
US - Idaho - Limits for Air Contaminants	hydrogen cyanide (Hydrogen cyanide)	10	11					
US - Hawaii Air Contaminant Limits	hydrogen cyanide (Hydrogen cyanide)			4.7	5			
US - Alaska Limits for Air Contaminants	hydrogen cyanide (Hydrogen cyanide)			4.7	5			
US - Michigan Exposure Limits for Air Contaminants	hydrogen cyanide (Hydrogen cyanide)			4.7	5			
Canada - Yukon Permissible Concentrations for Airborne Contaminant Substances	hydrogen cyanide (Hydrogen cyanide - Skin)	10	11	15	16			
US - Washington Permissible exposure limits of air contaminants	hydrogen cyanide (Hydrogen cyanide)			4.7				
Canada - Saskatchewan Occupational Health and Safety Regulations - Contamination Limits	hydrogen cyanide (Hydrogen cyanide and cyanide salts, (as CN): Hydrogen cyanide)					4.7		Skin
US - Oregon Permissible Exposure Limits (Z1)	hydrogen cyanide (Hydrogen cyanide)	10	11					

US - Wyoming Toxic and Hazardous Substances Table Z1 Limits for Air Contaminants	hydrogen cyanide (Hydrogen cyanide)	10	11						
Canada - Quebec Permissible Exposure Values for Airborne Contaminants (English)	hydrogen cyanide (Hydrogen cyanide)					10	11		
US OSHA Permissible Exposure Levels (PELs) - Table Z1	hydrogen cyanide (Hydrogen cyanide)	10	11						
Canada - Northwest Territories Occupational Exposure Limits (English)	hydrogen cyanide (Hydrogen cyanide - Skin)					10	11		
Canada - Nova Scotia Occupational Exposure Limits	hydrogen cyanide (Hydrogen cyanide)					4.7			Measured as CN. TLV Basis: upper respiratory tract irritation; headache; nausea; thyroid effects
Canada - Prince Edward Island Occupational Exposure Limits	hydrogen cyanide (Hydrogen cyanide)					4.7			Measured as CN. TLV Basis: upper respiratory tract irritation; headache; nausea; thyroid effects
Canada - Alberta Occupational Exposure Limits	hydrogen bromide (Hydrogen bromide)					2	6.6		
Canada - British Columbia Occupational Exposure Limits	hydrogen bromide (Hydrogen bromide Revised 2004)					2			
Canada - Ontario Occupational Exposure Limits	hydrogen bromide (Hydrogen bromide)					2			
US OSHA Permissible Exposure Levels (PELs) - Table Z1	hydrogen bromide (Hydrogen bromide)	3	10						
US ACGIH Threshold Limit Values (TLV)	hydrogen bromide (Hydrogen bromide)					2			TLV Basis: upper respiratory tract irritation
US NIOSH Recommended Exposure Limits (RELs)	hydrogen bromide (Hydrogen bromide)					3	10		
US - Tennessee Occupational Exposure Limits - Limits For Air Contaminants	hydrogen bromide (Hydrogen bromide)					3	10		
US - Vermont Permissible Exposure Limits Table Z-1-A Transitional Limits for Air Contaminants	hydrogen bromide (Hydrogen bromide)	3	10						
US - Vermont Permissible Exposure Limits Table Z-1-A Final Rule Limits for Air Contaminants	hydrogen bromide (Hydrogen bromide)					3	10		
US - Minnesota Permissible Exposure Limits (PELs)	hydrogen bromide (Hydrogen bromide)					3	10		

Cyanogen bromide

sc-203011

Material Safety Data Sheet

Hazard Alert Code Key:	EXTREME	HIGH	MODERATE	LOW

US - California Permissible Exposure Limits for Chemical Contaminants	hydrogen bromide (Hydrogen bromide)					3	10		
US - Idaho - Limits for Air Contaminants	hydrogen bromide (Hydrogen bromide)	3	10						
US - Hawaii Air Contaminant Limits	hydrogen bromide (Hydrogen bromide)					3	10		
US - Alaska Limits for Air Contaminants	hydrogen bromide (Hydrogen bromide)					3	10		
US - Michigan Exposure Limits for Air Contaminants	hydrogen bromide (Hydrogen bromide)					3	10		
Canada - Yukon Permissible Concentrations for Airborne Contaminant Substances	hydrogen bromide (Hydrogen bromide)	3	10	3	10				
US - Washington Permissible exposure limits of air contaminants	hydrogen bromide (Hydrogen bromide)					3.0			
Canada - Saskatchewan Occupational Health and Safety Regulations - Contamination Limits	hydrogen bromide (Hydrogen bromide)					2			
Canada - Prince Edward Island Occupational Exposure Limits	hydrogen bromide (Hydrogen bromide)					2			TLV Basis: upper respiratory tract irritation
US - Wyoming Toxic and Hazardous Substances Table Z1 Limits for Air Contaminants	hydrogen bromide (Hydrogen bromide)	3	10						
Canada - Quebec Permissible Exposure Values for Airborne Contaminants (English)	hydrogen bromide (Hydrogen bromide)					3	9,9		
US - Oregon Permissible Exposure Limits (Z1)	hydrogen bromide (Hydrogen bromide)	3	10						
Canada - Northwest Territories Occupational Exposure Limits (English)	hydrogen bromide (Hydrogen bromide)	3	9.9	6	20				
Canada - Nova Scotia Occupational Exposure Limits	hydrogen bromide (Hydrogen bromide)					2			TLV Basis: upper respiratory tract irritation

EMERGENCY EXPOSURE LIMITS

Material	Revised IDLH Value (mg/m3)	Revised IDLH Value (ppm)
cyanogen bromide	25	
hydrogen cyanide		50 [Unch]
hydrogen bromide		30

MATERIAL DATA

CYANOGEN BROMIDE:

HYDROGEN BROMIDE:

■ for hydrogen bromide:

Based on the results of controlled exposures of human volunteers, the recommended TLV-C should minimise even transient irritation and complaints which tend to decrease work efficiency. There is no implication that brief, small excursions above the ceiling are life-threatening or have the potential to create permanent harm.

Odour Safety Factor(OSF)
OSF=1 (HYDROGEN BROMIDE).
CYANOGEN BROMIDE:
HYDROGEN CYANIDE:
■ Hydrocyanic acid (hydrogen cyanide) Odour threshold: 0.2 - 5.0 ppm., recognition 2.0 - 5.0 ppm.
NOTE: Detector tubes for hydrocyanic acid, measuring in excess of 2 ppm, are commercially available. Long-term (8 hrs) measurements may be conducted to detect concentrations exceeding 1.3 ppm.
The recommended TLV-C is thought to provide protection against the significant risk of headache, fatigue, colic and nervousness observed in individuals exposed at 10 ppm in a full working shift. There are no rigorous studies which demonstrate objective signs of cyanide induced adverse health effects from long-term exposure to HCN in the workplace at concentrations equal to or less than 10 ppm. Although reports do exist which describe diverse and non-specific symptoms attributed to chronic exposures, other chemicals and stressors may also be implicated.
WARNING: Odour may give NO warning of exposure. Faint odour of almonds may be perceptible to some; but estimates give 40% of population as unable to detect odour of gas and odour fatigue is known to rapidly occur.

HCN Level in		Duration in minutes	Resulting Conditions on Humans
mg/m3	ppm		
2.2-5.5	2-5	-	Threshold of "bitter almonds" smell detectable by some people.
11	10	-	NOHSC peak limitation exposure standard.
19.8-39.6	18-36	Several hours	Slight symptoms of cyanide poisoning.
48.5-59.4	45-54	30-60 minutes	Tolerated without immediate or delayed effects.
121-148.5	110-135	30-60 minutes	Fatal, or dangerous to life.
148.5	135	30 minutes	Fatal.
199.1	181	10 minutes	Fatal.
297	270	Immediately	Immediately fatal.

.
CYANOGEN BROMIDE:
CEL TWA: 0.5 ppm, 2.2 mg/m3 [CHRIS]

PERSONAL PROTECTION

Consult your EHS staff for recommendations

EYE

■
- Chemical goggles.
- Full face shield.
- Contact lenses pose a special hazard; soft contact lenses may absorb irritants and all lenses concentrate them.

HANDS/FEET

■ Elbow length PVC gloves.
Suitability and durability of glove type is dependent on usage. Important factors in the selection of gloves include: such as:
- frequency and duration of contact,
- chemical resistance of glove material,
- glove thickness and
- dexterity

Select gloves tested to a relevant standard (e.g. Europe EN 374, US F739).
- When prolonged or frequently repeated contact may occur, a glove with a protection class of 5 or higher (breakthrough time greater than 240 minutes according to EN 374) is recommended.
- When only brief contact is expected, a glove with a protection class of 3 or higher (breakthrough time greater than 60 minutes according

to EN 374) is recommended.

- Contaminated gloves should be replaced.

Gloves must only be worn on clean hands. After using gloves, hands should be washed and dried thoroughly. Application of a non-perfumed moisturiser is recommended.

OTHER

■

- Overalls.
- PVC Apron.
- PVC protective suit may be required if exposure severe.
- Eyewash unit.
- Ensure there is ready access to a safety shower.

■

- Respirators may be necessary when engineering and administrative controls do not adequately prevent exposures.
- The decision to use respiratory protection should be based on professional judgment that takes into account toxicity information, exposure measurement data, and frequency and likelihood of the worker's exposure - ensure users are not subject to high thermal loads which may result in heat stress or distress due to personal protective equipment (powered, positive flow, full face apparatus may be an option).
- Published occupational exposure limits, where they exist, will assist in determining the adequacy of the selected respiratory . These may be government mandated or vendor recommended.
- Certified respirators will be useful for protecting workers from inhalation of particulates when properly selected and fit tested as part of a complete respiratory protection program.
- Use approved positive flow mask if significant quantities of dust becomes airborne.
- Try to avoid creating dust conditions.

RESPIRATOR

■ Where the concentration of gas/particulates in the breathing zone, approaches or exceeds the OSHA Permissible Exposure Limit (or PEL), respiratory protection is required.

Degree of protection varies with both face-piece and Class of filter; the nature of protection varies with Type of filter.

Protection Factor	Half-Face Respirator	Full-Face Respirator	Powered Air Respirator
10 x PEL	B-1 P	-	B-PAPR-1 P
50 x PEL	-	B-1 P	-
100 x PEL	-	B-2 P	B-PAPR-2 P^

^ - Full-face

Explanation of Respirator Codes:
Class 1 low to medium absorption capacity filters.
Class 2 medium absorption capacity filters.
Class 3 high absorption capacity filters.
PAPR Powered Air Purifying Respirator (positive pressure) cartridge.
Type A for use against certain organic gases and vapors.
Type AX for use against low boiling point organic compounds (less than 65ºC).
Type B for use against certain inorganic gases and other acid gases and vapors.
Type E for use against sulfur dioxide and other acid gases and vapors.
Type K for use against ammonia and organic ammonia derivatives
Class P1 intended for use against mechanically generated particulates of sizes most commonly encountered in industry, e.g. asbestos, silica.
Class P2 intended for use against both mechanically and thermally generated particulates, e.g. metal fume.
Class P3 intended for use against all particulates containing highly toxic materials, e.g. beryllium.

The local concentration of material, quantity and conditions of use determine the type of personal protective equipment required.

Use appropriate NIOSH-certified respirator based on informed professional judgement. In conditions where no reasonable estimate of exposure can be made, assume the exposure is in a concentration IDLH and use NIOSH-certified full face pressure demand SCBA with a minimum service life of 30 minutes, or a combination full facepiece pressure demand SAR with auxiliary self-contained air supply. Respirators provided only for escape from IDLH atmospheres shall be NIOSH-certified for escape from the atmosphere in which they will be used.

ENGINEERING CONTROLS

■

- Local exhaust ventilation is required where solids are handled as powders or crystals; even when particulates are relatively large, a certain proportion will be powdered by mutual friction.
- Exhaust ventilation should be designed to prevent accumulation and recirculation of particulates in the workplace.
- If in spite of local exhaust an adverse concentration of the substance in air could occur, respiratory protection should be considered. Such protection might consist of:

(a): particle dust respirators, if necessary, combined with an absorption cartridge;
(b): filter respirators with absorption cartridge or canister of the right type;

(c): fresh-air hoods or masks

- Build-up of electrostatic charge on the dust particle, may be prevented by bonding and grounding.
- Powder handling equipment such as dust collectors, dryers and mills may require additional protection measures such as explosion venting.

Air contaminants generated in the workplace possess varying "escape" velocities which, in turn, determine the "capture velocities" of fresh circulating air required to efficiently remove the contaminant.

Type of Contaminant:	Air Speed:
direct spray, spray painting in shallow booths, drum filling, conveyer loading, crusher dusts, gas discharge (active generation into zone of rapid air motion)	1-2.5 m/s (200-500 f/min.)
grinding, abrasive blasting, tumbling, high speed wheel generated dusts (released at high initial velocity into zone of very high rapid air motion).	2.5-10 m/s (500-2000 f/min.)

Within each range the appropriate value depends on:

Lower end of the range	Upper end of the range
1: Room air currents minimal or favorable to capture	1: Disturbing room air currents
2: Contaminants of low toxicity or of nuisance value only	2: Contaminants of high toxicity
3: Intermittent, low production.	3: High production, heavy use
4: Large hood or large air mass in motion	4: Small hood-local control only

Simple theory shows that air velocity falls rapidly with distance away from the opening of a simple extraction pipe. Velocity generally decreases with the square of distance from the extraction point (in simple cases). Therefore the air speed at the extraction point should be adjusted, accordingly, after reference to distance from the contaminating source. The air velocity at the extraction fan, for example, should be a minimum of 4-10 m/s (800-2000 f/min) for extraction of crusher dusts generated 2 meters distant from the extraction point. Other mechanical considerations, producing performance deficits within the extraction apparatus, make it essential that theoretical air velocities are multiplied by factors of 10 or more when extraction systems are installed or used.

Section 9 - PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL PROPERTIES

Solid.
Corrosive.
Contact with acids liberates very toxic gas.

State	Divided solid	Molecular Weight	105.93
Melting Range (°F)	125.6	Viscosity	Not Applicable
Boiling Range (°F)	142.52	Solubility in water (g/L)	Reacts
Flash Point (°F)	149	pH (1% solution)	Not available
Decomposition Temp (°F)	Not Available	pH (as supplied)	Not applicable
Autoignition Temp (°F)	Not available.	Vapor Pressure (mmHg)	99.758 @ 22.6 C
Upper Explosive Limit (%)	Not Available	Specific Gravity (water=1)	2.015 @ 20/4 C
Lower Explosive Limit (%)	Not Available	Relative Vapor Density (air=1)	3.6
Volatile Component (%vol)	Not applicable.	Evaporation Rate	Not available

APPEARANCE

Solid crystals, colourless, penetrating odour, corrodes most metals. Slightly soluble in water with decomposition and release of toxic gases. Soluble in alcohol, benzene and ether.

Section 10 - CHEMICAL STABILITY

CONDITIONS CONTRIBUTING TO INSTABILITY

■

- Presence of incompatible materials.
- Product is considered stable.
- Hazardous polymerization will not occur.

STORAGE INCOMPATIBILITY

■ Cyanogen bromide:

- may polymerise
- may be unstable unless dry and pure - impure material decomposes rapidly and tends to explode
- reacts violently with acids, ammonia, amines, phosgene

Hydrogen bromide:

- reacts with water to produce hydrobromic acid
- reacts violently with bases, ammonia, ferric oxide, strong oxidisers, fluorine, oxygen, nitrogen chloride and many organic compounds
- dry gas is incompatible with methyl vinyl ester
- aqueous solution is incompatible with aliphatic amines, alkanolamines, alkylene oxides, aromatic amines, amides, calcium oxide, epichlorohydrin, isocyanates, oleum, organic anhydrides, sulfuric acid, sodium tetrahydroborate, vinyl acetate
- aqueous solution is highly corrosive to most metals, forming flammable hydrogen gas

Hydrogen cyanide:

- can be self-reactive, forming an explosive mixture with air (flash point -18 C.)
- unless inhibited, material stored more than 90 days may be hazardous
- when heated above 180 C. or in contact with alkalis or amines can polymerise explosively
- reacts violently with strong oxidisers, acetaldehyde
- solutions containing more than 2-5% water are less stable than dry material
- in combination with strong oxidising acids can produce explosive violent decomposition
- acid solutions react with ammonia, ferric oxide, halogens, ozone
- attacks some plastics, rubber and coatings
- aqueous solutions attack carbon steels at room temperatures and stainless steels (especially if stabilised with sulfuric acid) above 80 C.
- Nitriles may polymerize in the presence of metals and some metal compounds.
- They are incompatible with acids; mixing nitriles with strong oxidizing acids can lead to extremely violent reactions.
- Nitriles are generally incompatible with other oxidizing agents such as peroxides and epoxides.
- The combination of bases and nitriles can produce hydrogen cyanide. Nitriles are hydrolyzed exothermally in both aqueous acid and base to give carboxylic acids (or salts of carboxylic acids).
- Nitriles can react vigorously with reducing agents.
- Contact with acids produces toxic fumes

Reacts with mild steel, galvanized steel / zinc producing hydrogen gas which may form an explosive mixture with air.
WARNING:
May decompose violently or explosively on contact with other substances.

- This substance is one of the relatively few compounds which are described as "endothermic" i.e. heat is absorbed into the compound, rather than released from it, during its formation.
- The majority of endothermic compounds are thermodynamically unstable and may decompose explosively under various circumstances of initiation.
- Many but not all endothermic compounds have been involved in decompositions, reactions and explosions and, in general, compounds with significantly positive values of standard heats of formation, may be considered suspect on stability grounds.

BRETHERICK L.: Handbook of Reactive Chemical Hazards.
Segregate from alcohol, water.
Avoid reaction with oxidizing agents.

- NOTE: May develop pressure in containers; open carefully. Vent periodically.

For incompatible materials - refer to Section 7 - Handling and Storage.

Section 11 - TOXICOLOGICAL INFORMATION

cyanogen bromide

TOXICITY AND IRRITATION

■ unless otherwise specified data extracted from RTECS - Register of Toxic Effects of Chemical Substances.

TOXICITY	IRRITATION
Inhalation (human) LCLo: 92 ppm/10m	Nil Reported

■ Asthma-like symptoms may continue for months or even years after exposure to the material ceases. This may be due to a non-allergenic condition known as reactive airways dysfunction syndrome (RADS) which can occur following exposure to high levels of highly irritating compound. Key criteria for the diagnosis of RADS include the absence of preceding respiratory disease, in a non-atopic individual, with abrupt onset of persistent asthma-like symptoms within minutes to hours of a documented exposure to the irritant. A reversible airflow pattern, on spirometry, with the presence of moderate to severe bronchial hyperreactivity on methacholine challenge testing and the lack of minimal lymphocytic inflammation, without eosinophilia, have also been included in the criteria for diagnosis of RADS. RADS (or asthma) following an irritating inhalation is an infrequent disorder with rates related to the concentration of and duration of exposure to the irritating substance. Industrial bronchitis, on the other hand, is a disorder that occurs as result of exposure due to high concentrations of irritating substance (often particulate in nature) and is completely reversible after exposure ceases. The disorder is characterised by dyspnea, cough and mucus production.

CARCINOGEN

BROMINE COMPOUNDS (ORGANIC OR INORGANIC)	US Environmental Defense Scorecard Suspected Carcinogens	Reference(s)	P65-MC
INORGANIC BROMINE COMPOUNDS	US Environmental Defense Scorecard Suspected Carcinogens	Reference(s)	P65-MC

SKIN

cyanogen bromide	US - Washington Permissible exposure limits of air contaminants - Skin	Skin	X
cyanogen bromide	US - Hawaii Air Contaminant Limits - Skin Designation	Skin Designation	X
cyanogen bromide	US OSHA Permissible Exposure Levels (PELs) - Skin	Skin Designation	X
cyanogen bromide	US - California Permissible Exposure Limits for Chemical Contaminants - Skin	Skin	X
cyanogen bromide	US - California Permissible Exposure Limits for Chemical Contaminants - Skin	Skin	S
hydrogen cyanide	Canada - Ontario Occupational Exposure Limits - Skin	Notes	Skin
hydrogen cyanide	US AIHA Workplace Environmental Exposure Levels (WEELs) - Skin	Notes	Skin
hydrogen cyanide	US NIOSH Recommended Exposure Limits (RELs) - Skin	Skin	Yes
hydrogen cyanide	Canada - Quebec Permissible Exposure Values for Airborne Contaminants - Skin (French)	Notes	Skin
hydrogen cyanide	US - Tennessee Occupational Exposure Limits - Limits For Air Contaminants - Skin	Skin Designation	X
hydrogen cyanide	US - Vermont Permissible Exposure Limits Table Z-1-A Transitional Limits for Air Contaminants - Skin	Skin Designation	X
hydrogen cyanide	US - Vermont Permissible Exposure Limits Table Z-1-A Final Rule Limits for Air Contaminants - Skin	Skin Designation	X
hydrogen cyanide	US - Washington Permissible exposure limits of air contaminants - Skin	Skin	X
hydrogen cyanide	US ACGIH Threshold Limit Values (TLV) - Skin	Skin Designation	Yes
hydrogen cyanide	Canada - British Columbia Occupational Exposure Limits - Skin	Notation	Skin
hydrogen cyanide	US - Minnesota Permissible Exposure Limits (PELs) - Skin	Skin Designation	X
hydrogen cyanide	US - Hawaii Air Contaminant Limits - Skin Designation	Skin Designation	X
hydrogen cyanide	ND	Skin Designation	X

hydrogen cyanide	US OSHA Permissible Exposure Levels (PELs) - Skin	Skin Designation	X
hydrogen cyanide	US - California Permissible Exposure Limits for Chemical Contaminants - Skin	Skin	X
hydrogen cyanide	US - California Permissible Exposure Limits for Chemical Contaminants - Skin	Skin	S
hydrogen cyanide	Canada - Alberta Occupational Exposure Limits - Skin	Substance Interaction	1

Section 12 - ECOLOGICAL INFORMATION

Refer to data for ingredients, which follows:
HYDROGEN BROMIDE:
CYANOGEN BROMIDE:

- Bromide ion may be introduced to the environment after the dissociation of various salts and complexes or the degradation of organobromide compounds.

Although not a significant toxin in mammalian or avian systems it is highly toxic to rainbow trout and Daphnia magna. Bromides may also affect the growth of micro-organisms and have been used for this purpose in industry.

Bromides in drinking water are occasionally subject to disinfection processes involving ozone of chlorine. Bromide may be oxidised to produce hypobromous acid which in turn may react with natural organic matter to form brominated compounds. The formation of bromoform has been well documented, as has the formation of bromoacetic acids, bromopicrin, cyanogen bromide, and bromoacetone. Bromates may also be formed following ozonation or chlorination if pH is relatively high. Bromates may be animal carcinogens.

HYDROGEN CYANIDE:
HYDROGEN BROMIDE:
CYANOGEN BROMIDE:

- DO NOT discharge into sewer or waterways.

HYDROGEN CYANIDE:
CYANOGEN BROMIDE:

- Very toxic to aquatic organisms.
- Soil Guidelines: Dutch Criteria:

free cyanide: 1 mg/kg (target)
20 mg/kg (intervention)
complex cyanide (pH 5): 5 mg/kg (target)
50 mg/kg (intervention)
Air Quality Standards: no safe guidelines recommended due to carcinogenic properties.

- The alkali metal cyanides (and other metal cyanides) are very soluble in water. As a result, they readily dissociate into their respective anions and cations when released into water. Depending on the pH of the water, the resulting cyanide ion may then form hydrogen cyanide or react with various metals in natural water. The proportion of hydrogen cyanide formed from soluble cyanides increases as the water pH decreases. At pH <7, >99% of the cyanide ions in water are converted to hydrogen cyanide. As the pH increases, cyanide ions in the water may form complex metallocyanides in the presence of excess cyanides; however, if metals are prevalent, simple metal cyanides are formed.

Volatilization is the dominant mechanism for the removal of free cyanide. At pH >9.2, most of the free cyanide should exist as HCN, a volatile form of cyanide. Wide variations in the rate of volatilization are expected since this process is affected by a number of parameters such as temperature, pH, wind speed, and cyanide concentration. Volatilization of free cyanide from concentrated solutions is most effective under conditions of high temperatures, high dissolved oxygen levels, and at increased concentrations of atmospheric carbon dioxide

Unlike water-soluble alkali metal cyanides, insoluble metal cyanides are not expected to degrade to hydrogen cyanide. Cyanide occurs most commonly as hydrogen cyanide in water, although it can also occur as the cyanide ion, alkali and alkaline earth metal cyanides (potassium cyanide, sodium cyanide, calcium cyanide), relatively stable metallocyanide complexes (ferricyanide complex [Fe(CN)6]-3), moderately stable metallocyanide complexes (complex nickel and copper cyanide), or easily decomposable metallocyanide complexes (zinc cyanide [Zan(CN)2], cadmium cyanide [Cd(CN)2]). Oxidation, hydrolysis, and photolysis (photodegradation) are the three predominant chemical processes that may cause loss of simple cyanides in aquatic media.

Certain cyanides are oxidised to isocyanates by strong oxidising agents; the isocyanates may be further hydrolysed to ammonia and carbon dioxide. However, it has not yet been determined whether such oxidation and subsequent hydrolysis of isocyanate is a significant fate process in natural waters known to contain peroxy radicals. In water, hydrogen cyanide and cyanide ion exist in equilibrium with their relative concentrations primarily dependent on pH and temperature. At pH <8, >93% of the free cyanide in water will exist as undissociated hydrogen cyanide. Hydrogen cyanide can be hydrolysed to formamide, which is subsequently hydrolysed to ammonium and formate ions. However, the relatively slow rates of hydrolysis reported for hydrogen cyanide in acidic solution and of cyanides under alkaline conditions indicate that hydrolysis is not competitive with volatilisation and biodegradation for removal of free cyanide from ambient waters At pH <9.2, most of the free cyanide in solution should exist as hydrogen cyanide, a volatile cyanide form. On the basis of Henry's law constant and the volatility characteristics associated with various ranges of Henry's law constant, volatilization is a significant and probably dominant fate process for

hydrogen cyanide in surface water. The most common alkali metal cyanides (e.g., sodium and potassium cyanide) may also be lost from surface water primarily through volatilization; whereas, the sparingly soluble metal cyanides such as copper (I) cyanide are removed from water predominantly by sedimentation and biodegradation. Because volatilisation is not an important fate process for cyanide in groundwater, cyanide would be expected to persist for considerably longer periods of time in underground aquifers than in surface water.
The significance of photolysis in the fate of cyanides in water has not been fully investigated. Hydrogen cyanide and cyanide ions in aqueous solution have been found to be very resistant to photolysis by natural sunlight, except under heterogeneous photocatalytic conditions. Photocatalytic oxidation may not be significant in natural waters, however, because of significant light reduction at increasingly greater depths. In clear water or at water surfaces, some metallocyanides, such as ferrocyanides and ferricyanides, may decompose to the cyanide ion by photodissociation and subsequently form hydrogen cyanide.
Biodegradation is an important transformation process for cyanide in natural surface waters, and is dependent on such factors as cyanide concentrations, pH, temperature, availability of nutrients, and acclimation of microbes. Although the cyanide ion is toxic to microorganisms at concentrations as low as 5-10 mg/L, acclimation increases tolerance to this compound. Mixed microorganisms in sewage sludge or activated sludge acclimated to cyanide also significantly biodegrade concentrations <=100 mg/L of most simple and complex cyanides. It is known that there is a natural attentuation of the cyanide ion and thiocyanide concentrations in waste waters, for example those obtained gold mill tails, that is due the acclimation of indigenous microflora in the tailings. A number of microorganisms have been identified that are capable of uptake, conversion, sorption, and/or precipitation of the cyanide ion, cyanate, and thiocyanate, including species of the genera, Actinomyces, Alcaligenes, Arthrobacter, Bacillus, Micrococcus, Neisseria, Paracoccus, Pseudomonas, and Thiobacillus. Some of these species, for example Pseudomonas, are capable of using the cyanide ion and thiocyanate as the sole source of carbon and nitrogen and therefore, are particularly effective at cyanide degradation. In fact, Pseudomonas is the basis of commercial applications for degrading the cyanide ion to ammonia and carbonate in waste waters generated in mining operations that use the cyanide ion to leach gold and other precious metals for low-grade ores. Sulfur transferases such as rhodanese are involved in substitution reactions that result in the conversion of the cyanide ion to the less toxic thiocyanate, whereas pyridoxal phosphate enzymes are involved in substitution/addition reactions that result in production of nitrile derivatives of a-amino acids. These organic nitriles may then be ultimately degraded via enzyme catalysed hydrolysis to either the corresponding amino acid and ammonia or the carboxylic acid and ammonia. The cyanide hydratase and cyanidase enzymes catalyse the hydrolysis of the cyanide ion to formamide or formic acid and ammonia, respectively In soil, cyanide present at low concentrations would biodegrade under aerobic conditions with the initial formation of ammonia, which would be converted to nitrite and nitrate in the presence of nitrifying bacteria. Under anaerobic conditions, the cyanides ion will denitrify to gaseous nitrogen. Upper limits of 200 and 2 ppm (mg/kg CN–), respectively, have been reported for uninhibited aerobic and anaerobic biodegradation of cyanide in soil; however, these limits have not been confirmed in other studies. Cyanide ions in soil are not involved in oxidation-reduction reactions but may undergo complexation reactions with metal ions in soil
Cyanides are sorbed by various natural media, including clays, biological solids and sediments Hydrogen cyanide and the alkali metal cyanides are not likely to be strongly sorbed onto sediments and suspended solids because of their high water solubilities. Soluble metal cyanides may show somewhat stronger sorption than hydrogen cyanide, with the extent of sorption increasing with decreasing pH and increasing iron oxide, clay, and organic material contents of sediment and suspended solids. However, sorption is probably insignificant even for metal cyanides when compared to volatilisation and biodegradation. Cyanides are fairly mobile in soil. Mobility is lowest in soils with low pH and high concentrations of free iron oxides, positively charged particles, and clays (e.g., chlorite, kaolin, gibbsite), and highest in soils with high pH, high concentrations of free CaCO3 and negatively charged particles, and low clay content. Although cyanide has a low soil sorption capability, it is usually not detected in groundwater, probably because of fixation by trace metals through complexation or transformation by soil microorganisms. In soils where cyanide levels are high enough to be toxic to microorganisms (i.e., landfills, spills), this compound may leach into groundwater. Leaching of cyanide into a shallow aquifer has been demonstrated. Volatilisation of hydrogen cyanide would be a significant loss mechanism for cyanides from soil surfaces at a pH <9.2.
Most cyanide in the atmosphere exists almost entirely as hydrogen cyanide gas, although small amounts of metal cyanides may be present as particulate matter in the air. Hydrogen cyanide is very resistant to photolysis at wavelengths of normal sunlight. The most important reaction of hydrogen cyanide in air is the reaction with photochemically-generated hydroxyl radicals and subsequent rapid oxidation to carbon monoxide (CO) and nitric oxide (NO); photolysis and reaction with ozone are not important transformation processes, and reaction with singlet oxygen is not a significant transformation process except at stratospheric altitudes where singlet oxygen is present in significant concentrations. The rate of hydroxyl radical reaction with hydrogen cyanide in the atmosphere depends on the altitude, and the rate of the reaction is at least an order of magnitude faster at lower tropospheric altitudes (0–8 km) than at upper tropospheric altitudes (10–12 km). Based on a reaction rate constant of 3x10-14 cm3/(molecule-sec) at 25 °C and assuming an average hydroxyl radical concentration of 5x105 molecules/cm3, the residence time for the reaction of hydrogen cyanide vapor with hydroxyl radicals in the atmosphere is approximately 2 years
There is some evidence that certain metal cyanide complexes bioaccumulate in aquatic organisms. Fish from water with soluble silver and copper cyanide complexes were found to have metal cyanides in their tissues at concentrations ranging up to 168 and 304 µg/g, respectively (wet or dry weight not specified). It is difficult to evaluate the toxicologic significance of bioaccumulation of metal cyanide complexes because these compounds are much less toxic than soluble hydrogen cyanide, sodium cyanide, or potassium cyanide. There is no evidence of biomagnification of cyanides in the food chain. Accumulation of cyanide in food webs is not expected, considering the rapid detoxification of cyanide by most species and the lethal effects of large doses of cyanide.
■ Do NOT allow product to come in contact with surface waters or to intertidal areas below the mean high water mark. Do not contaminate water when cleaning equipment or disposing of equipment wash-waters.
Wastes resulting from use of the product must be disposed of on site or at approved waste sites.
■ On the basis of available evidence concerning either toxicity, persistence, potential to accumulate and or observed environmental fate and behaviour, the material may present a danger, immediate or long-term and /or delayed, to the structure and/ or functioning of natural

ecosystems.
CYANOGEN BROMIDE:

Marine Pollutant:	Yes

Fish LC50 (96 h): 15 mg/l
HYDROGEN CYANIDE:

Marine Pollutant:	Yes
■ Hazardous Air Pollutant:	Yes
■ Fish LC50 (96hr.) (mg/l):	5.3E- 06 -
■ Algae IC50 (72hr.) (mg/l):	1.8
■ log Pow (Verschueren 1983):	0.35/1.07

/53#R58#90mp#90etox1
log Kow: 0.35-1.07
Toxicity invertebrate: cell mult. inhib. prtz 0.24mg/L
HYDROGEN BROMIDE:
■ Harmful to aquatic organisms.

Ecotoxicity

Ingredient	Persistence: Water/Soil	Persistence: Air	Bioaccumulation	Mobility
cyanogen bromide	HIGH		LOW	HIGH
hydrogen cyanide			LOW	

Section 13 - DISPOSAL CONSIDERATIONS

US EPA Waste Number & Descriptions

A. General Product Information
Corrosivity characteristic: use EPA hazardous waste number D002 (waste code C)
Reactivity characteristic: use EPA hazardous waste number D003 (waste code R).
B. Component Waste Numbers
When cyanogen bromide is present as a solid waste as a discarded commercial chemical product, off-specification species, as a container residue, or a spill residue, use EPA waste number U246 (waste code T).
When hydrogen cyanide is present as a solid waste as a discarded commercial chemical product, off-specification species, as a container residue, or a spill residue, use EPA waste number P063 (waste code T).

Disposal Instructions

All waste must be handled in accordance with local, state and federal regulations.
¦ Puncture containers to prevent re-use and bury at an authorized landfill.
Legislation addressing waste disposal requirements may differ by country, state and/ or territory. Each user must refer to laws operating in their area. In some areas, certain wastes must be tracked.
A Hierarchy of Controls seems to be common - the user should investigate:

- Reduction
- Reuse
- Recycling
- Disposal (if all else fails)

This material may be recycled if unused, or if it has not been contaminated so as to make it unsuitable for its intended use. Shelf life considerations should also be applied in making decisions of this type. Note that properties of a material may change in use, and recycling or reuse may not always be appropriate.
DO NOT allow wash water from cleaning equipment to enter drains. Collect all wash water for treatment before disposal.

- Recycle wherever possible.
- Consult manufacturer for recycling options or consult Waste Management Authority for disposal if no suitable treatment or disposal facility can be identified.
- Treat and neutralize at an approved treatment plant.
- Treatment should involve: Mixing or slurrying in water Neutralization followed by: Burial in a licensed land-fill or Incineration in a licensed apparatus (after admixture with suitable combustible material)
- Decontaminate empty containers. Observe all label safeguards until containers are cleaned and destroyed.

Section 14 - TRANSPORTATION INFORMATION

DOT:

Symbols:	None	Hazard class or Division:	6.1
Identification Numbers:	UN1889	PG:	I
Label Codes:	6.1, 8	Special provisions:	A6, A8, T6, TP33
Packaging: Exceptions:	None	Packaging: Non-bulk:	211
Packaging: Exceptions:	None	Quantity limitations: Passenger aircraft/rail:	1 kg
Quantity Limitations: Cargo aircraft only:	15 kg	Vessel stowage: Location:	D
Vessel stowage: Other:	40	S.M.P.:	YES

Hazardous materials descriptions and proper shipping names:
Cyanogen bromide

Air Transport IATA:

ICAO/IATA Class:	6.1 (8)	ICAO/IATA Subrisk:	None
UN/ID Number:	1889	Packing Group:	-
Special provisions:	A2		
Cargo Only			
Packing Instructions:	Forbidden	Maximum Qty/Pack:	Forbidden
Passenger and Cargo		Passenger and Cargo	
Packing Instructions:	Forbidden	Maximum Qty/Pack:	Forbidden
Passenger and Cargo Limited Quantity		Passenger and Cargo Limited Quantity	
Packing Instructions:	-	Maximum Qty/Pack:	-

Shipping Name: CYANOGEN BROMIDE

Maritime Transport IMDG:

IMDG Class:	6.1	IMDG Subrisk:	8
UN Number:	1889	Packing Group:	I
EMS Number:	F-A,S-B	Special provisions:	None
Limited Quantities:	None	Marine Pollutant:	Yes

Shipping Name: CYANOGEN BROMIDE

Section 15 - REGULATORY INFORMATION

cyanogen bromide (CAS: 506-68-3) is found on the following regulatory lists;

"Canada Domestic Substances List (DSL)","Canada Ingredient Disclosure List (SOR/88-64)","Canada Toxicological Index Service - Workplace Hazardous Materials Information System - WHMIS (English)","Canada Toxicological Index Service - Workplace Hazardous Materials Information System - WHMIS (French)","US - Massachusetts Oil & Hazardous Material List","US - New Jersey Right to Know Hazardous Substances","US - Pennsylvania - Hazardous Substance List","US - Rhode Island Hazardous Substance List","US - Vermont Hazardous Constituents","US - Vermont Hazardous wastes which are Discarded Commercial Chemical Products or Off-Specification Batches of Commercial Chemical Products or Spill Residues of Either","US - Washington Dangerous waste constituents list","US - Washington Discarded Chemical Products List - ""U"" Chemical Products","US Department of Transportation (DOT) List of Hazardous Substances and Reportable Quantities - Hazardous Substances Other Than Radionuclides","US Department of Transportation (DOT) Marine Pollutants - Appendix B","US DOE Temporary Emergency Exposure Limits (TEELs)","US List of Lists - Consolidated List of Chemicals Subject to the

Emergency Planning and Community Right-to-Know Act (EPCRA) and Section 112(r) of the Clean Air Act","US RCRA (Resource Conservation & Recovery Act) - Hazardous Constituents - Appendix VIII to 40 CFR 261","US RCRA (Resource Conservation & Recovery Act) - List of Hazardous Wastes","US SARA Section 302 Extremely Hazardous Substances","US Toxic Substances Control Act (TSCA) - Inventory"

Regulations for ingredients

hydrogen cyanide (CAS: 74-90-8) is found on the following regulatory lists;

"Canada - Alberta Occupational Exposure Limits","Canada - British Columbia Occupational Exposure Limits","Canada - Northwest Territories Occupational Exposure Limits (English)","Canada - Nova Scotia Occupational Exposure Limits","Canada - Ontario Occupational Exposure Limits","Canada - Prince Edward Island Occupational Exposure Limits","Canada - Quebec Permissible Exposure Values for Airborne Contaminants (English)","Canada - Saskatchewan Occupational Health and Safety Regulations - Contamination Limits","Canada - Yukon Permissible Concentrations for Airborne Contaminant Substances","Canada Chemical Weapons Schedule 3 (English)","Canada Domestic Substances List (DSL)","Canada Ingredient Disclosure List (SOR/88-64)","Canada National Pollutant Release Inventory (NPRI)","Canada Toxicological Index Service - Workplace Hazardous Materials Information System - WHMIS (English)","Canada Toxicological Index Service - Workplace Hazardous Materials Information System - WHMIS (French)","Canada Transport Dangerous Goods - Schedule 3","Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction (English)","International Air Transport Association (IATA) Dangerous Goods Regulations","International Air Transport Association (IATA) Dangerous Goods Regulations - Prohibited List","International Council of Chemical Associations (ICCA) - High Production Volume List","International Maritime Dangerous Goods Requirements (IMDG Code) - Goods Forbidden for Transport","OECD Representative List of High Production Volume (HPV) Chemicals","US - Alaska Limits for Air Contaminants","US - California Air Toxics ""Hot Spots"" List (Assembly Bill 2588) Substances for which emissions must be quantified","US - California Occupational Safety and Health Regulations (CAL/OSHA) - Hazardous Substances List","US - California OEHHA/ARB - Acute Reference Exposure Levels and Target Organs (RELs)","US - California OEHHA/ARB - Chronic Reference Exposure Levels and Target Organs (CRELs)","US - California Permissible Exposure Limits for Chemical Contaminants","US - Connecticut Hazardous Air Pollutants","US - Hawaii Air Contaminant Limits","US - Idaho - Limits for Air Contaminants","US - Massachusetts Oil & Hazardous Material List","US - Michigan Exposure Limits for Air Contaminants","US - Minnesota Hazardous Substance List","US - Minnesota Permissible Exposure Limits (PELs)","US - New Jersey Right to Know Hazardous Substances","US - Oregon Hazardous Materials","US - Oregon Permissible Exposure Limits (Z1)","US - Pennsylvania - Hazardous Substance List","US - Rhode Island Hazardous Substance List","US - Tennessee Occupational Exposure Limits - Limits For Air Contaminants","US - Vermont Hazardous Constituents","US - Vermont Hazardous Waste - Acutely Hazardous Wastes","US - Vermont Permissible Exposure Limits Table Z-1-A Final Rule Limits for Air Contaminants","US - Vermont Permissible Exposure Limits Table Z-1-A Transitional Limits for Air Contaminants","US - Washington Dangerous waste constituents list","US - Washington Discarded Chemical Products List - ""P"" Chemical Products","US - Washington Permissible exposure limits of air contaminants","US - Wyoming List of Highly Hazardous Chemicals, Toxics and Reactives","US - Wyoming Toxic and Hazardous Substances Table Z1 Limits for Air Contaminants","US ACGIH Threshold Limit Values (TLV)","US CERCLA Priority List of Hazardous Substances","US CWA (Clean Water Act) - List of Hazardous Substances","US CWA (Clean Water Act) - Reportable Quantities of Designated Hazardous Substances","US Department of Homeland Security Chemical Facility Anti-Terrorism Standards - Chemicals of Interest","US Department of Transportation (DOT) List of Hazardous Substances and Reportable Quantities - Hazardous Substances Other Than Radionuclides","US Department of Transportation (DOT) Marine Pollutants - Appendix B","US Department of Transportation (DOT), Hazardous Material Table","US Department of Transportation (DOT), Hazardous Material Table : Goods Forbidden for Transport","US DOE Temporary Emergency Exposure Limits (TEELs)","US EPA Acute Exposure Guideline Levels (AEGLs) - Final","US EPA High Production Volume Chemicals Additional List","US EPA Master Testing List - Index I Chemicals Listed","US EPCRA Section 313 Chemical List","US List of Lists - Consolidated List of Chemicals Subject to the Emergency Planning and Community Right-to-Know Act (EPCRA) and Section 112(r) of the Clean Air Act","US NFPA 45 Fire Protection for Laboratories Using Chemicals - Flammability Characteristics of Common Compressed and Liquefied Gases","US NIOSH Recommended Exposure Limits (RELs)","US OSHA List of Highly Hazardous Chemicals, Toxics and Reactives","US OSHA Permissible Exposure Levels (PELs) - Table Z1","US Postal Service (USPS) Hazardous Materials Table: Postal Service Mailability Guide","US RCRA (Resource Conservation & Recovery Act) - Hazardous Constituents - Appendix VIII to 40 CFR 261","US RCRA (Resource Conservation & Recovery Act) - List of Hazardous Wastes","US SARA Section 302 Extremely Hazardous Substances","US Spacecraft Maximum Allowable Concentrations (SMACs) for Airborne Contaminants","US Toxic Substances Control Act (TSCA) - Inventory"

hydrogen bromide (CAS: 10035-10-6) is found on the following regulatory lists;

"Canada - Alberta Occupational Exposure Limits","Canada - British Columbia Occupational Exposure Limits","Canada - Northwest Territories Occupational Exposure Limits (English)","Canada - Nova Scotia Occupational Exposure Limits","Canada - Ontario Occupational Exposure Limits","Canada - Prince Edward Island Occupational Exposure Limits","Canada - Quebec Permissible Exposure Values for Airborne Contaminants (English)","Canada - Saskatchewan Industrial Hazardous Substances","Canada - Saskatchewan Occupational Health and Safety Regulations - Contamination Limits","Canada - Yukon Permissible Concentrations for Airborne Contaminant Substances","Canada Domestic Substances List (DSL)","Canada Ingredient Disclosure List (SOR/88-64)","Canada Toxicological Index Service - Workplace Hazardous Materials Information System - WHMIS (English)","Canada Toxicological Index Service - Workplace Hazardous Materials Information System - WHMIS (French)","International Council of Chemical Associations (ICCA) - High Production Volume List","OECD Representative List of High Production Volume (HPV) Chemicals","US - Alaska Limits for Air Contaminants","US - California Occupational Safety and Health Regulations (CAL/OSHA) - Hazardous Substances List","US - California Permissible Exposure Limits for Chemical Contaminants","US - Connecticut Hazardous Air Pollutants","US - Hawaii Air Contaminant Limits","US - Idaho - Limits for Air Contaminants","US - Massachusetts Oil & Hazardous Material List","US - Michigan Exposure Limits for Air Contaminants","US - Minnesota Hazardous Substance List","US - Minnesota Permissible Exposure Limits (PELs)","US - New Jersey Right to Know Hazardous Substances","US - Oregon Hazardous Materials","US - Oregon Permissible Exposure Limits (Z1)","US - Pennsylvania - Hazardous

Substance List","US - Rhode Island Hazardous Substance List","US - Tennessee Occupational Exposure Limits - Limits For Air Contaminants","US - Vermont Permissible Exposure Limits Table Z-1-A Final Rule Limits for Air Contaminants","US - Vermont Permissible Exposure Limits Table Z-1-A Transitional Limits for Air Contaminants","US - Washington Permissible exposure limits of air contaminants","US - Wyoming List of Highly Hazardous Chemicals, Toxics and Reactives","US - Wyoming Toxic and Hazardous Substances Table Z1 Limits for Air Contaminants","US ACGIH Threshold Limit Values (TLV)","US Department of Homeland Security Chemical Facility Anti-Terrorism Standards - Chemicals of Interest","US DOE Temporary Emergency Exposure Limits (TEELs)","US EPA Acute Exposure Guideline Levels (AEGLs) - Interim","US EPA High Production Volume Chemicals Additional List","US NFPA 45 Fire Protection for Laboratories Using Chemicals - Flammability Characteristics of Common Compressed and Liquefied Gases","US NIOSH Recommended Exposure Limits (RELs)","US OSHA List of Highly Hazardous Chemicals, Toxics and Reactives","US OSHA Permissible Exposure Levels (PELs) - Table Z1","US Postal Service (USPS) Hazardous Materials Table: Postal Service Mailability Guide","US Toxic Substances Control Act (TSCA) - Inventory"

Section 16 - OTHER INFORMATION

LIMITED EVIDENCE

- Cumulative effects may result following exposure*.
- May be harmful to the fetus/ embryo*.

* (limited evidence).

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- Classification of the mixture and its individual components has drawn on official and authoritative sources as well as independent review by the Chemwatch Classification committee using available literature references.
A list of reference resources used to assist the committee may be found at:
www.chemwatch.net/references.

- The (M)SDS is a Hazard Communication tool and should be used to assist in the Risk Assessment. Many factors determine whether the reported Hazards are Risks in the workplace or other settings. Risks may be determined by reference to Exposures Scenarios. Scale of use, frequency of use and current or available engineering controls must be considered.

Issue Date: Oct-4-2008

Print Date:May-6-2010