



MATERIAL SAFETY DATA SHEET

Prepared to U.S. OSHA, CMA, ANSI, Canadian WHMIS Standards and EC Standards

SECTION 1. PRODUCT IDENTIFICATION

PRODUCT NAME: CARBON DIOXIDE
CHEMICAL NAME: Carbon Dioxide
FORMULA: CO₂
SYNONYMS: Carbon Anhydride; Carbonic Acid Gas; Carbonic Anhydride; Carbon Dioxide USP; Carbon Dioxide, Refrigerated Liquid

MANUFACTURER: SPECTRA GASES, INC.
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 Branchburg, NJ 08876, U.S.A.
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WEB SITE: www.spectra-gases.com

SPECTRA GASES EMERGENCY CONTACT: 800/932-0624 8:30 am - 7:00 pm (EST)
24 HOUR EMERGENCY CONTACT, CHEMTREC: 800/424-9300, 703-527-3887
DATE OF PREPARATION: January 29, 2001
MSDS NUMBER: 1010
PRODUCT USE: Various

SECTION 2. COMPOSITION and INFORMATION ON INGREDIENTS

COMPOSITION: Carbon Dioxide 100%
CAS NUMBER: Carbon Dioxide: 124-38-9
EINECS NUMBER: Carbon Dioxide: 204-696-9
EXPOSURE LIMITS:

	OSHA PELs:	ACGIH TLVs:	NIOSH RELs:
Carbon Dioxide:			
TWA =	5,000 ppm	TWA = 5,000 ppm	TWA = 5,000 ppm
TWA =	10,000 ppm (vacated 1989 PEL)	STEL = 30,000 ppm	STEL = 30,000 ppm
STEL =	30,000 ppm (vacated 1989 PEL)		IDLH = 40,000 ppm

SECTION 3. HAZARD IDENTIFICATION

EMERGENCY OVERVIEW: Carbon Dioxide is a colorless, odorless gas, or a colorless, odorless liquid in a high-pressure container. Over-exposure to Carbon Dioxide can increase respiration and heart rate, possibly resulting in circulatory insufficiency, which may lead to coma and death. At concentrations between 2 and 10%, Carbon Dioxide can cause nausea, dizziness, headache, mental confusion, increased blood pressure and respiratory rate. Exposure to Carbon Dioxide can also cause asphyxiation, through displacement of oxygen. If the gas concentration reaches 10% or more, suffocation can occur within minutes. The liquid will rapidly boil to the gas at standard temperatures and pressures. Contact with the cold gas can cause freezing of exposed tissue. Moisture in the air could lead to the formation of carbonic acid which can be irritating to the eyes. All forms of Carbon Dioxide are non-combustible.

ROUTES OF ENTRY, SYMPTOMS OF ACUTE EXPOSURE: WARNING - If rescue personnel need to enter an area suspected of having a high level of Carbon Dioxide, they should be equipped with Self-Contained Breathing Apparatus (SCBA), and other appropriate protective equipment. Acute overexposure to this gas mixture may cause the following health effects:

EYE CONTACT: Contact of the cold gas with the eyes can cause pain, redness, burns, and severe exposure could cause blindness.

INGESTION: Ingestion of this gas mixture is not a likely route of industrial exposure.

SKIN CONTACT: Contact of the cold gas with the skin can lead to frostbite or dermatitis (red, cracked, irritated skin), depending upon concentration and duration of exposure.

SECTION 3. HAZARD IDENTIFICATION (Continued)

INHALATION: Exposure to Carbon Dioxide can produce significant, adverse health effects at relatively low concentrations. Carbon Dioxide is an asphyxiant and a powerful cerebral vasodilator. If the concentration of Carbon Dioxide reaches 10% or more, suffocation can occur within minutes. If inhaled at concentrations between 2-10%, Carbon Dioxide can cause nausea, dizziness, headache, mental confusion, increased blood pressure and respiratory rate. Carbon Dioxide initially stimulates respiration and then causes respiratory depression. Repeated inhalation of low concentrations (3-5%) have no known permanent harmful effects. If this gas mixture is inhaled, symptoms from exposure Carbon Dioxide which may develop include those described below.

CONCENTRATION**of CARBON DIOXIDE****EXPOSURE SYMPTOM**

1%	Slight increase in breathing rate.
2%	Breathing rate increases to 50% above normal level. Prolonged exposure can cause headache, tiredness.
3%	Breathing increases to twice normal rate and becomes labored. Weak narcotic effect. Impaired hearing, headache, increase in blood pressure and pulse rate.
4-5%	Breathing increases to approximately four times normal rate, symptoms of intoxication become evident and slight choking may be felt.
5-10%	Characteristic sharp odor noticeable. Very labored breathing, headache, visual impairment and ringing in the ears. Judgment may be impaired, followed within minutes by loss of consciousness.
50-100%	Unconsciousness occurs more rapidly above 10% level. Prolonged exposure to high concentrations may eventually result in death from asphyxiation.

An additional health hazard associated with this gas is asphyxiation after inhalation of oxygen-deficient environments. If large volumes of this gas mixture are released or if this gas mixture is released in poorly-ventilated areas (i.e., enclosed or confined spaces), an oxygen-deficient environment may occur. It should be noted that before adverse health effects or suffocation could occur, the effects of overexposure to Carbon Dioxide will be felt. Individuals breathing an oxygen-deficient atmosphere may experience symptoms that include headaches, ringing in ears, dizziness, drowsiness, unconsciousness, nausea, vomiting, and depression of all the senses. The following effects associated with various levels of oxygen are as follows:

CONCENTRATION**of OXYGEN****EXPOSURE SYMPTOM**

20.9% Oxygen:	Normal oxygen concentration in air.
15-19% Oxygen:	Decreased ability to perform tasks. May impair coordination and may induce early symptoms in persons with heart, lung, or circulatory problems.
12-15% Oxygen:	Breathing increases, especially in exertion. Pulse up. Impaired coordination, perception, and judgment.
10-12% Oxygen:	Breathing further increases in rate and depth, poor coordination and judgment, lips slightly blue.
8-10% Oxygen:	Mental failure, fainting, unconsciousness, ashen face, blueness of lips, nausea (upset stomach), and vomiting.
6-8% Oxygen:	8 minutes, may be fatal in 50-100% of cases; 6 minutes, may be fatal in 25 to 50% of cases; 4-5 minutes, recovery with treatment.
4-6% Oxygen:	Coma in 40 seconds, followed by convulsion, breathing failure, death.

WARNING: Exposure to atmospheres containing 8-10% or less oxygen will bring about unconsciousness without warning and so quickly that individuals cannot help or protect themselves. Lack of sufficient oxygen may cause serious injury or death.

HMIS RATINGS: CARBON DIOXIDE, GAS: HEALTH: = 1; FLAMMABILITY: = 0; REACTIVITY: = 0;
 PPE: Level B (see Section 8, Exposure Controls/Personal protective Equipment)
 CARBON DIOXIDE, LIQUEFIED: : HEALTH: = 3; FLAMMABILITY: = 0; REACTIVITY: = 0;
 PPE: Level X (see Section 8, Exposure Controls/Personal protective Equipment)

ROUTES OF ENTRY, SYMPTOMS OF CHRONIC EXPOSURE:

ROUTE OF ENTRY: Inhalation, Eyes

TARGET ORGANS: Eyes.

SYMPTOMS: Prolonged contact of high concentrations of Carbon Dioxide with the eyes can cause damage to the retinal ganglion cells.

SECTION 3. HAZARD IDENTIFICATION (Continued)

MEDICAL CONDITIONS AGGRAVATED BY OVEREXPOSURE: Acute or chronic respiratory conditions and eye conditions may be aggravated by over-exposure to this gas mixture.

CARCINOGENICITY: Carbon Dioxide is not found on the FEDERAL OSHA Z LIST, NTP, CAL/OSHA, or IARC Carcinogenicity lists and therefore are neither considered to be nor suspected to be cancer-causing agents by these agencies.

SECTION 4. FIRST AID MEASURES

EYE CONTACT: If irritation of the eye develops after exposure to this gas, open victim's eyes while under gentle, lukewarm, running water. Use sufficient force to open eyelids. Have victim "roll" eyes. Minimum flushing is for 15 minutes. Victim must seek immediate medical attention from an ophthalmologist.

INGESTION: Ingestion is an unlikely route of exposure for this gas.

INHALATION: Remove victim(s) to fresh air, as quickly as possible. Trained personnel should administer supplemental oxygen and/or cardio-pulmonary resuscitation, if necessary.

SKIN CONTACT: In case of frostbite, place the frostbitten part in warm water. DO NOT USE HOT WATER. If warm water is not available, or is impractical to use, wrap the affected parts gently in blankets. Alternatively, if the fingers or hands are frostbitten, place the affected area in the armpit. Encourage victim to gently exercise the affected part while being warmed. Seek immediate medical attention.

NOTES TO PHYSICIANS: Administer oxygen, if necessary and treat symptoms.

SECTION 5. FIRE FIGHTING MEASURES

FLASH POINT: Not Applicable

AUTOIGNITION: Not Applicable

FLAMMABLE RANGE: Not Applicable

NFPA RATINGS:

FOR CARBON DIOXIDE GAS:

HEALTH: = 1

REACTIVITY: = 0

FLAMMABILITY: = 0

SPECIAL: None

FOR CARBON DIOXIDE LIQUEFIED:

HEALTH: = 3

REACTIVITY: = 0

FLAMMABILITY: = 0

SPECIAL: None

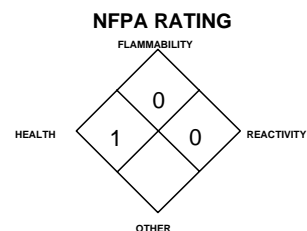
EXTINGUISHING MEDIA: Carbon Dioxide is commonly used as an extinguishing agent for Class B and Class C fires. Use extinguishing media appropriate for the surrounding fire.

SPECIAL FIRE-FIGHTING PROCEDURES: Evacuate all personnel from area. If possible without risk, shut off source of gas, then fight fire according to types of materials burning. If cylinder is not actively a part of the fire, remove from fire area. If this is not possible, cool cylinder with a water spray to prevent violent rupture. Fire fighters must wear Self-Contained Breathing Apparatus and full protective equipment. If necessary, decontaminate fire-response equipment with soap and water solution.

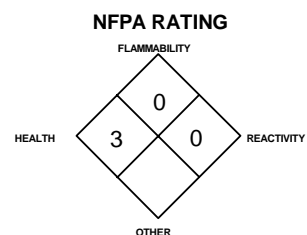
UNUSUAL FIRE AND EXPLOSION HAZARDS: Carbon Dioxide presents a significant inhalation hazard to firefighters. Carbon Dioxide does not burn; however, containers, when involved in fire, may rupture or burst in the heat of the fire. Dusts of various reactive metals (e.g., magnesium, zircon, titanium alloys), are readily ignited and explode in the presence of Carbon Dioxide. In the presence of moisture, cesium oxide ignites on contact with Carbon Dioxide. Metal acetylides or hydrides will also ignite or explode.

Liquid Carbon Dioxide will vaporize rapidly when accidentally released, forming an oxygen-deficient vapor cloud. Additionally, if large concentrations of Carbon Dioxide gas are present, the water vapor in the surrounding air will condense, creating a dense fog. Evacuate the surrounding area; visibility may be obscured in such a vapor cloud making it difficult to find fire exits or equipment. Pressure in a high pressure container can build-up due to heat and it may rupture if pressure relief devices should fail to function. Contact with cold, gaseous or solid Carbon Dioxide may cause frostbite.

CARBON DIOXIDE GAS



CARBON DIOXIDE LIQUEFIED



**See Section 16 for
Definition of Ratings**

SECTION 5. FIRE FIGHTING MEASURES (Continued)

EXPLOSION SENSITIVITY TO MECHANICAL IMPACT: Not sensitive.

EXPLOSION SENSITIVITY TO STATIC DISCHARGE: Not sensitive.

HAZARDOUS COMBUSTION PRODUCTS: Carbon Dioxide will produce carbon monoxide and oxygen when heated to temperatures above 1648°C (3000°F).

SECTION 6. ACCIDENTAL RELEASE MEASURES

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED: In the event of a leak of Carbon Dioxide, operator should close the gas source if possible to do so safely. Evacuate immediate area. Only trained personnel, wearing Self-Contained Breathing Apparatus (SCBA) and other appropriate personal protective equipment should re-enter a contaminated area.

Persons responding to a release of a pressurized gas should be aware of the severe hazard of mechanical injury in the event of valve failure or other event causing a rapid release of cylinder contents.

If leak is in user's gas handling equipment or system, close cylinder valve, safely vent high pressure and purge with inert gas, being sure to bring purge gas to near atmospheric pressure before attempting repairs. If leak is from the cylinder, cylinder valve or the valve pressure relief device (PRD), contact your supplier.

Levels of Carbon Dioxide should be below applicable exposure levels listed in Section 2 (Composition / Information on Ingredients) and oxygen level should be above 19.5% before personnel can be allowed in the area without SCBA.

Detection systems should be available to monitor for leaks and to measure the level of Carbon Dioxide.

SECTION 7. HANDLING AND STORAGE

STORAGE: Cylinders should be stored upright (with valve protection caps or plugs in place) and firmly secured to prevent falling or being knocked over. Cylinders should be stored in dry, well-ventilated areas. Protect from salt or other corrosive materials. Storage should be away from heavily traveled areas, walkways, elevators, platform edges or other objects or situations that could damage the cylinder wall. Do not store in a manner that will block emergency exits, fire extinguishers or other safety equipment. Do not allow storage temperature to exceed 125°F (52°C). Use a first-in, first-out inventory system to prevent full containers from being stored for long periods of time. Store empty cylinders away from full cylinders. Consideration should be taken to install leak detection and alarm equipment for storage areas. **NOTE:** Use only DOT or ASME code cylinders designed for compressed gas storage. Cylinders must not be recharged except by or with the consent of owner.

HANDLING: Carbon Dioxide can be dangerous and should only be handled by trained personnel. Wearing contact lenses is not recommended when handling this gas mixture.

Before using this gas, meticulous leak checking using inert gas is strongly recommended, particularly after new connections are made. Cylinder valves should be inspected regularly for physical damage or corrosion (apparent by discoloration or rust). Close valve after each use and when empty.

Carbon Dioxide and/or detectors for oxygen deficiency, are strongly recommended. Do not drag, roll, slide or drop cylinder. Use a suitable hand truck designed for cylinder movement. Never attempt to lift a cylinder by its cap. Secure cylinders at all times while in use. Use a pressure regulator to safely discharge product from cylinder. Use a check valve to prevent reverse flow into cylinder. Once cylinder has been connected to properly purged process, open cylinder valve slowly and carefully. If user experiences any difficulty operating cylinder valve, discontinue use and contact supplier. Never insert an object (e.g., wrench, screwdriver, etc.) into valve cap openings; doing so may damage valve, causing a leak to occur. Use an adjustable strap-wrench to remove over-tight or rusted caps. Do not heat cylinders by any means to increase the discharge rate of product from the cylinder. Never apply flame or localized heat directly to any part of the cylinder. Cylinders should not be artificially cooled as certain types of steel undergo property changes when cryogenically cooled, thus making the cylinder unstable.

PROTECTIVE PRACTICES DURING MAINTENANCE OF CONTAMINATED EQUIPMENT: Follow practices indicated in Section 6 (Accidental Release Measures). Relieve pressure before attempting repairs.

SPECIAL PRECAUTIONS: Be aware of any signs of dizziness or fatigue; exposures to fatal concentrations of this gas mixture could occur without any significant warning symptoms. All work operations should be monitored in such a way that emergency personnel can be immediately contacted in the event of a release. Always store and handle compressed gas cylinders in accordance with Compressed Gas Association, Inc. (telephone 703-412-0900) pamphlet CGA P-1, *Safe Handling of Compressed Gases in Containers*. Local regulations may require specific equipment for storage and use.

SECTION 7. HANDLING AND STORAGE (Continued)

SPECIAL PRECAUTIONS FOR HANDLING PRESSURIZED CONTAINERS OF LIQUID CARBON DIOXIDE:

Cold liquids can present significant safety hazards. Never allow any unprotected part of the body to touch uninsulated pipes or vessels which contain cold fluids. The extremely cold metal of the container will cause moist flesh to stick fast and tear when one attempts to withdraw from it. The following rules are applicable to work situations in which liquid containers are being used.

Check all hoses and transfer equipment before filling them with the liquid. Replace any worn or cut hoses prior to use. Liquid Carbon Dioxide is extremely cold and is under pressure. A leak will result in the formation of "Dry Ice" particles which will be forcibly ejected from the system, possibly injuring the operator. A complete hose failure can result in a large release of Carbon Dioxide and violent movement of the hose and associated equipment, which may cause severe injury or death. Special care must be taken when depressurizing and disconnecting hoses. Releasing the contents of a liquid-filled line to atmospheric pressure may result in the formation of a solid dry ice plug in the line. This plug will prevent further removal of the liquid behind the plug, resulting in either an unexpected, rapid release of Carbon Dioxide as the line warms, or the catastrophic failure of the line as the liquid warms behind the plug. Sufficient vapor pressure must be applied and maintained behind the liquid before opening a discharge valve. This action will prevent the depressurization of the liquid to the point of solid formation before it exits the line.

High-pressure containers for liquid product are equipped with pressure relief devices to control internal pressure. Under normal conditions, these containers will periodically vent small amounts of product. Some metals such as carbon steel may become brittle at low temperatures and will easily fracture. Prevent entrapment of liquid in closed systems or piping without pressure relief devices.

SECTION 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

VENTILATION AND ENGINEERING CONTROLS: Forced ventilation systems for the general work area should be provided. Employee exposure should be monitored and reduced to the lowest practical levels using ventilation or other appropriate engineering controls. If appropriate, install automatic monitoring equipment to detect the level of Carbon Dioxide.

RESPIRATORY PROTECTION: Maintain exposure levels of Carbon Dioxide below the levels listed in Section 2 (Composition / Information on Ingredients) and oxygen levels above 19.5% in the workplace. Use supplied air respiratory protection if Carbon Dioxide levels exceed exposure limits, if oxygen level is below 19.5%, or during emergency response to a release of this product. If respiratory protection is required, follow the requirements of the U.S. Federal OSHA Respiratory Protection Standard (29 CFR 1910.134), or equivalent U.S. State standards, Canadian CSA Standard Z94.4-93, the European Standard EN149, and EC member states. The following NIOSH respiratory protection recommendations are for Carbon Dioxide.

CONCENTRATION of

RESPIRATORY EQUIPMENT

CARBON DIOXIDE

Up to 40,000 ppm:

Supplied Air Respirator (SAR); or full-facepiece Self-Contained Breathing Apparatus (SCBA).

Emergency or Planned Entry into Unknown Concentrations or IDLH Conditions: Positive pressure, full-facepiece SCBA; or positive pressure, full-facepiece SAR with an auxiliary positive pressure SCBA.

Escape: Escape-type SCBA. The IDLH concentration for Carbon Dioxide is 40,000 ppm.

EYE PROTECTION: Use approved safety goggles or safety glasses, as described in OSHA 29 CFR 1910.133 or by the European Standard EN166. Eye wash stations/safety showers should be available.

SKIN PROTECTION: Work (such as leather) gloves are recommended when handling cylinders of this gas. Wear gloves when handling cylinders of Carbon Dioxide. Use chemical-resistant gloves in emergency situations.

OTHER PROTECTIVE EQUIPMENT: Use body protection appropriate for task. Safety shoes are recommended when handling cylinders.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

MOLECULAR WEIGHT: 44.01

SUBLIMATION POINT: -78.5°C (-109.3°F)

LIQUID DENSITY @ 21.1°C (70°F) and 838 psig (5778 kPa): 47.35 lb/ft³ (761.3 kg/m³)

FREEZING/MELTING POINT: (sublimation temperature) -78.5°C (-109.3°F)

TRIPLE POINT: -55.6°C (-69.9°F) @ 60.4 psig (416 kPa)

pH: 3.7 at 1 atm (from carbonic acid)

SPECIFIC GRAVITY (air = 1) @ 70°F (21.1°C): 1.522

MOLECULAR WEIGHT: 44.01

ODOR THRESHOLD: Odorless.

EXPANSION RATIO: Not applicable.

EVAPORATION RATE (nBuAc = 1): Not applicable.

SPECIFIC VOLUME (ft³/lb): 8.76

(continued on following page)

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

VAPOR PRESSURE @ 21.1°C (70°F) psig: 838 psig (5778 kPa)

SOLUBILITY IN WATER vol/vol 20°C (68°F) and 1 atm: 0.90

CRITICAL PRESSURE: 1070.6 psia (73829 kPa abs)

COEFFICIENT WATER/OIL DISTRIBUTION: Not applicable.

APPEARANCE, ODOR AND STATE: Carbon Dioxide is a colorless, odorless gas, or colorless, odorless, volatile liquid stored under high pressure. As this gas is slightly acidic, some individuals may notice a slightly pungent odor and biting taste.

WARNING PROPERTIES FOR THIS GAS MIXTURE: There are no distinct warning properties, except the potential of a vapor cloud in the event of a large release. Monitoring for levels of Carbon Dioxide and oxygen deficiency are recommended.

SECTION 10. STABILITY AND REACTIVITY

CHEMICAL STABILITY: Stable.

CONDITIONS TO AVOID: Cylinders should not be exposed to temperatures in excess of 125°F (52°C).

MATERIALS WITH WHICH GAS IS INCOMPATIBLE: Carbon Dioxide will ignite and explode when heated with powdered aluminum, beryllium, cerium alloys, chromium, magnesium-aluminum alloys, manganese, thorium, titanium, and zirconium. In the presence of moisture, Carbon Dioxide will ignite with cesium oxide. Metal acetylides will also ignite and explode on contact with Carbon Dioxide. Carbon Dioxide will react with alkaline materials to form carbonates and bicarbonates..

REACTIVITY:

A) HAZARDOUS DECOMPOSITION PRODUCTS: Carbon Dioxide will react with alkaline materials to form carbonates and bicarbonates. In addition, in the presence of ultraviolet light or electrical discharge, Carbon Dioxide decomposes to carbon monoxide and oxygen.

B) HAZARDOUS POLYMERIZATION: Will not occur.

SECTION 11. TOXICOLOGICAL INFORMATION

TOXICITY DATA ON COMPONENTS: Carbon Dioxide is an asphyxiant gas, which has physiological effects at high concentrations. High concentrations can also result in narcosis. The following are toxicological data currently available for Carbon Dioxide.

CARBON DIOXIDE:

LCLo (Inhalation-Human) 9 pph/5 minutes

TCLo (Inhalation-Rat) 10000 ppm/24 hours/30 days-continuous: Blood: other changes

TCLo (Inhalation-Rat) 6 pph/24 hours: female 10 day(s) after conception; Reproductive: Specific Developmental Abnormalities: musculoskeletal system, cardiovascular (circulatory) system, respiratory system

TCLo (Inhalation-Rat) 6 pph/24 hours: female 10 day(s) after conception: Reproductive: Effects on Newborn: growth statistics (e.g. %, reduced weight gain)

CARBON DIOXIDE (continued):

TCLo (Inhalation-Mouse) 55 pph/2 hours: male 3 day(s) pre-mating:

Reproductive: Paternal Effects: spermatogenesis (incl. genetic material, sperm morphology, motility, and count)

TCLo (Inhalation-Mouse) 2 pph/8 hours: female 10 day(s) after conception: Reproductive: Fertility: post-implantation mortality (e.g. dead and/or resorbed implants per total number of implants), Reproductive: Specific Developmental Abnormalities: musculoskeletal system

CARBON DIOXIDE (continued):

TCLo (Inhalation-Mouse) 55 pph/4 hours: male 6 day(s) pre-mating: Reproductive: Fertility: male fertility index (e.g. # males impregnating females per # males exposed to fertile non-pregnant females)

TCLo (Inhalation-Rabbit) 27000 ppm/24 hours/30 days-continuous: Behavioral: somnolence (general depressed activity)

TCLo (Inhalation-Rabbit) 13 pph/4 hours: female 9-12 day(s) after conception: Reproductive: Specific Developmental Abnormalities: musculoskeletal system

LCLo (Inhalation-Mammal-species unspecified) 90000 ppm/5 minutes

CARCINOGENICITY: Carbon Dioxide has not been found to be carcinogenic.

IRRITANCY OF PRODUCT: Carbon Dioxide irritates the eyes and may irritate the skin. In addition, contact with rapidly expanding gases can cause frostbite to exposed tissue.

SENSITIZATION OF PRODUCT: Carbon Dioxide is not known to cause sensitization in humans.

REPRODUCTIVE TOXICITY INFORMATION: Listed below is information concerning the effects of Carbon Dioxide on the human reproductive system.

Mutagenicity: Carbon Dioxide is not expected to cause mutagenic effects in humans.

Embryotoxicity: Carbon Dioxide is not expected to cause embryotoxic effects in humans.

Teratogenicity: Carbon Dioxide is not expected to cause teratogenic effects in humans. Clinical studies involving test animals exposed to high concentrations of Carbon Dioxide indicate teratogenic effects.

Reproductive Toxicity: This gas mixture is not expected to cause adverse reproductive effects in humans. Clinical studies involving test animals exposed to high concentrations of Carbon Dioxide indicate reproductive effects.

SECTION 11. TOXICOLOGICAL INFORMATION (Continued)

REPRODUCTIVE TOXICITY INFORMATION (continued):

A mutagen is a chemical that causes permanent changes to genetic material (DNA) such that the changes will propagate through generational lines. An embryotoxin is a chemical that causes damage to a developing embryo (i.e., within the first eight weeks of pregnancy in humans), but the damage does not propagate across generational lines. A teratogen is a chemical that causes damage to a developing fetus, but the damage does not propagate across generational lines. A reproductive toxin is any substance that interferes in any way with the reproductive process.

BIOLOGICAL EXPOSURE INDICES (BEIs): Currently, Biological Exposure Indices (BEIs) are not applicable for Carbon Dioxide.

SECTION 12. ECOLOGICAL INFORMATION

ENVIRONMENTAL STABILITY: Carbon Dioxide will be dissipated rapidly in well-ventilated areas. The following environmental data are available for Carbon Dioxide.

Food chain concentration potential: None. Biological Oxygen Demand: None. Log P = 0.83

EFFECT OF MATERIAL ON PLANTS or ANIMALS: Any adverse effect on plants would be related to oxygen-deficient environments or frost from rapidly expanding gases, unless exposure occurs in a confined space. Carbon Dioxide may have adverse effects on animal life exposed to very high concentrations.

EFFECT OF CHEMICAL ON AQUATIC LIFE: Carbon Dioxide may have adverse effects on aquatic life. Currently, the following aquatic toxicity data are available for Carbon Dioxide:

Lethal (trout) 1 hour = 240 mg/L

Lethal (rainbow trout) 96 hours = 35 mg/L

Harmful to some species of aquatic life in concentrations less than 20 mg/L

Lethal (rainbow trout) 12 hours = 60-240 mg/L

MOBILITY: Carbon Dioxide will not be mobile in the soil.

PERSISTENCE AND BIODEGRADABILITY: Persistence Carbon Dioxide persists in the atmosphere. Biodegradation: Carbon Dioxide does not biodegrade, but will decompose in ultraviolet light to form carbon monoxide and oxygen.

POTENTIAL TO BIOACCUMULATE: Carbon Dioxide does not have bioaccumulation or food chain contamination potential.

OZONE-DEPLETION POTENTIAL: Carbon Dioxide is not Class I or Class II ozone depleting chemicals (40 CFR Part 82).

SECTION 13. DISPOSAL CONSIDERATIONS

UNUSED PRODUCT / EMPTY CONTAINER: Do not dispose of residual product. Return residual product in cylinders to: Spectra Gases, Inc., 80 Industrial Drive, Alpha, NJ 08865 or Spectra Gases, Inc., 1261 Activity Drive, Vista, CA 92083.

DISPOSAL INFORMATION: For emergency disposal, slowly discharge in well-ventilated area or outdoors. This shall be done in accordance with U.S. Federal, State and local regulations, regulations of the provinces of Canada or EC member states.

SECTION 14. TRANSPORT INFORMATION

U.S. SHIPPING INFORMATION:

	<u>FOR GAS</u>	<u>FOR LIQUID</u>
PROPER SHIPPING NAME:	Carbon dioxide	Carbon Dioxide, refrigerated liquid
HAZARD CLASS NUMBER and DESCRIPTION:	2.2 (Non-Flammable Gas)	2.2 (Non-Flammable Gas)
UN IDENTIFICATION NUMBER:	UN 1013	UN 2817
PACKING GROUP:	Not Applicable	Not Applicable
DOT LABEL(S) REQUIRED:	Non-Flammable Gas	Non-Flammable Gas
PLACARD (When required):	Not Applicable	

SPECIAL SHIPPING INFORMATION: Cylinders should be transported in a secure position. Ensure cylinder valve is properly closed, valve outlet cap has been reinstalled, and valve protection cap is secured before shipping cylinder.

CAUTION: Compressed gas cylinders shall not be refilled except by qualified producers of compressed gases. Shipment of a compressed gas cylinder which has not been filled by the owner or with the owner's written consent is a violation of Federal law (49 CFR 173.301).

NAERG (NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK) #: 120

SECTION 14. TRANSPORT INFORMATION (Continued)
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CANADIAN SHIPPING INFORMATION:

TRANSPORT CANADA TRANSPORTATION OF DANGEROUS GOODS REGULATIONS: Carbon Dioxide is considered as dangerous goods; use the above U.S. DOT information for the preparation of Canadian Shipments.

INTERNATIONAL AIR TRANSPORT ASSOCIATION SHIPPING INFORMATION (IATA):

IATA DESIGNATION: Carbon Dioxide is considered as dangerous goods, per the International Air Transport Association.

	<u>FOR GAS</u>	<u>FOR LIQUID</u>
PROPER SHIPPING NAME:	Carbon dioxide	Carbon Dioxide, refrigerated liquid
HAZARD CLASS NUMBER and DESCRIPTION:	2.2 (Non-Flammable Gas)	2.2 (Non-Flammable Gas)
UN IDENTIFICATION NUMBER:	UN 1013	UN 2817
PACKING GROUP:	Not Applicable	Not Applicable
HAZARD LABEL(S) REQUIRED:	Non-Flammable Gas	Non-Flammable Gas
ERG CODE:	2L	2L

The following Packaging Information is applicable to Carbon Dioxide, Gas:

PASSENGER AND CARGO AIRCRAFT				CARGO AIRCRAFT ONLY	
Limited Quantity					
Packing Instruction	Max. Qty per Pkg	Packing Instruction	Max. Qty per Pkg	Packing Instruction	Max. Qty per Pkg
//////	//////	200	75 kg	200	150 kg

The following Packaging Information is applicable to Carbon Dioxide, Refrigerated Liquid:

PASSENGER AND CARGO AIRCRAFT				CARGO AIRCRAFT ONLY	
Limited Quantity					
Packing Instruction	Max. Qty per Pkg	Packing Instruction	Max. Qty per Pkg	Packing Instruction	Max. Qty per Pkg
//////	//////	202	50 kg	202	500 kg

INTERNATIONAL MARITIME ORGANIZATION SHIPPING INFORMATION (IMO):

IMO DESIGNATION: This gas mixture is considered as dangerous goods, per the International Maritime Organization.

	<u>FOR GAS</u>	<u>FOR LIQUID</u>
PROPER SHIPPING NAME:	Carbon dioxide	Carbon Dioxide, refrigerated liquid
HAZARD CLASS NUMBER and DESCRIPTION:	2.2 (Non-Flammable Gas)	2.2 (Non-Flammable Gas)
UN IDENTIFICATION NUMBER:	UN 1013	UN 2817
PACKING GROUP:	Not Applicable	Not Applicable
HAZARD LABEL(S) REQUIRED:	Non-Flammable Gas	Non-Flammable Gas
STOWAGE CATEGORY:	Category A	Category B
IMDG CODE:	Page 2111	

MARINE POLLUTANT: Carbon Dioxide is not designated by the IMO to be a Marine Pollutant.

EUROPEAN SHIPPING INFORMATION:

EUROPEAN AGREEMENT CONCERNING THE INTERNATIONAL CARRIAGE OF DANGEROUS GOODS BY ROAD (ADR): This gas mixture is considered by the Economic Commission for Europe to be dangerous goods. Additional information is as follows:

	<u>FOR GAS</u>	<u>FOR LIQUID</u>
SUBSTANCE IDENTIFICATION NO.:	1013	2817
NAME OF SUBSTANCE:	Carbon dioxide	Carbon Dioxide, refrigerated liquid
HAZARD IDENTIFICATION NO.:	20	22
LABEL:	2	2
CLASS AND ITEM NUMBER:	2, 2°A	2, 3°A

SECTION 15. REGULATORY INFORMATION

U.S. FEDERAL REGULATIONS:**EPA - ENVIRONMENTAL PROTECTION AGENCY:**

CERCLA: Comprehensive Environmental Response, Compensation, and Liability Act of 1990
(40 CFR Parts 117 and 302)

Reportable Quantity (RQ): Carbon Dioxide = Not applicable.

SARA TITLE III: Superfund Amendment and Reauthorization Act

SECTIONS 302/304: Emergency Planning and Notification (40 CFR Part 355)

Extremely Hazardous Substances: Carbon Dioxide is not listed.

Threshold Planning Quantity (TPQ): Not applicable.

Reportable Quantity (RQ): Not applicable.

SECTIONS 311/312: Hazardous Chemical Reporting (40 CFR Part 370)

IMMEDIATE HEALTH: Yes

PRESSURE: Yes

DELAYED HEALTH: No

REACTIVITY: No

FIRE: No

SECTION 313: Toxic Chemical Release Reporting (40 CFR 372)

Releases of Carbon Dioxide does not require reporting under Section 313.

CLEAN AIR ACT:

SECTION 112 (r): Risk Management Programs for Chemical Accidental Release
(40 CFR Part 68)

Threshold Planning Quantity (TPQ): Not applicable.

TSCA: Toxic Substances Control Act

Carbon Dioxide is listed on the TSCA Inventory.

OSHA - OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION:

29 CFR Part 1910.119: Process Safety Management of Highly Hazardous Chemicals.

Threshold Planning Quantity (TPQ): Not applicable

U.S. STATE REGULATORY INFORMATION:

CALIFORNIA PROPOSITION 65: Carbon Dioxide is not on the California Proposition 65 lists.

Carbon Dioxide is listed by the following State regulations (more specific regulations exist in some States):

Alaska - Designated Toxic and Hazardous Substances: Carbon Dioxide.

Michigan - Critical Materials Register: Carbon Dioxide.

Pennsylvania - Hazardous Substance List: Carbon Dioxide.

California - Permissible Exposure Limits for Chemical Contaminants: Carbon Dioxide.

Minnesota - List of Hazardous Substances: Carbon Dioxide.

Rhode Island - Hazardous Substance List: Carbon Dioxide.

Florida - Substance List: Carbon Dioxide.

Missouri - Employer Information/Toxic Substance List: Carbon Dioxide.

Texas - Hazardous Substance List: Carbon Dioxide.

Illinois - Toxic Substance List: Carbon Dioxide.

New Jersey - Right to Know Hazardous Substance List: Carbon Dioxide.

West Virginia - Hazardous Substance List: Carbon Dioxide.

Kansas - Section 302/313 List: No.

North Dakota - List of Hazardous Chemicals, Reportable Quantities: No.

Wisconsin - Toxic and Hazardous Substances: Carbon Dioxide.

Massachusetts - Substance List: Carbon Dioxide.

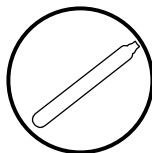
CANADIAN FEDERAL REGULATIONS:

CANADIAN DSL INVENTORY STATUS: Carbon Dioxide is listed on the Canadian DSL Inventory.

OTHER CANADIAN REGULATIONS: Carbon Dioxide is categorized as a Controlled Product, Hazard Class A, as per the Controlled Product Regulations. The components of this product are not on the CEPA Priorities Substances Lists.

CANADIAN WHMIS SYMBOLS:

Class A: Compressed Gas



DEFINITIONS OF TERMS

A large number of abbreviations and acronyms appear on a MSDS. Some of these which are commonly used include the following:

CAS #: This is the Chemical Abstract Service Number which uniquely identifies each constituent. It is used for computer-related searching.

EXPOSURE LIMITS IN AIR:

ACGIH - American Conference of Governmental Industrial Hygienists, a professional association which establishes exposure limits.

TLV - Threshold Limit Value - an airborne concentration of a substance which represents conditions under which it is generally believed that nearly all workers may be repeatedly exposed without adverse effect. The duration must be considered, including the 8-hour Time Weighted Average (**TWA**), the 15-minute Short Term Exposure Limit (**STEL**), and the instantaneous Ceiling Level (**C**). Skin absorption effects must also be considered.

OSHA - U.S. Occupational Safety and Health Administration.

PEL - Permissible Exposure Limit - This exposure value means exactly the same as a TLV, except that it is enforceable by OSHA. The OSHA Permissible Exposure Limits are based in the 1989 PELs and the June, 1993 Air Contaminants Rule (Federal Register: 58: 35338-35351 and 58: 40191). Both the current PELs and the vacated PELs are indicated. The phrase, "Vacated 1989 PEL," is placed next to the PEL which was vacated by Court Order.

IDLH - Immediately Dangerous to Life and Health - This level represents a concentration from which one can escape within 30-minutes without suffering escape-preventing or permanent injury.

The DFG - MAK is the Republic of Germany's Maximum Exposure Level, similar to the U.S. PEL.

NIOSH is the National Institute of Occupational Safety and Health, which is the research arm of the U.S. Occupational Safety and Health Administration (**OSHA**). NIOSH issues exposure guidelines called **Recommended Exposure Levels (RELs)**. When no exposure guidelines are established, an entry of **NE** is made for reference.

HAZARD RATINGS:

HAZARDOUS MATERIALS IDENTIFICATION SYSTEM: Health Hazard: **0** (minimal acute or chronic exposure hazard); **1** (slight acute or chronic exposure hazard); **2** (moderate acute or significant chronic exposure hazard); **3** (severe acute exposure hazard; onetime overexposure can result in permanent injury and may be fatal); **4** (extreme acute exposure hazard; onetime overexposure can be fatal). Flammability Hazard: **0** (minimal hazard); **1** (materials that require substantial pre-heating before burning); **2** (combustible liquid or solids; liquids with a flash point of 38-93°C [100-200°F]); **3** (Class IB and IC flammable liquids with flash points below 38°C [100°F]); **4** (Class IA flammable liquids with flash points below 23°C [73°F] and boiling points below 38°C [100°F]). Reactivity Hazard: **0** (normally stable); **1** (material that can become unstable at elevated temperatures or which can react slightly with water); **2** (materials that are unstable but do not detonate or which can react violently with water); **3** (materials that can detonate when initiated or which can react explosively with water); **4** (materials that can detonate at normal temperatures or pressures).

NATIONAL FIRE PROTECTION ASSOCIATION: Health Hazard: **0** (material that on exposure under fire conditions would offer no hazard beyond that of ordinary combustible materials); **1** (materials that on exposure under fire conditions could cause irritation or minor residual injury); **2** (materials that on intense or continued exposure under fire conditions could cause temporary incapacitation or possible residual injury); **3** (materials that can on short exposure could cause serious temporary or residual injury); **4** (materials that under very short exposure could cause death or major residual injury). Flammability Hazard and Reactivity Hazard: Refer to definitions for "Hazardous Materials Identification System".

FLAMMABILITY LIMITS IN AIR:

Much of the information related to fire and explosion is derived from the National Fire Protection Association (**NFPA**). Flash Point - Minimum temperature at which a liquid gives off sufficient vapors to form an ignitable mixture with air. Autoignition Temperature: The minimum temperature required to initiate combustion in air with no other source of ignition. LEL - the lowest percent of vapor in air, by volume, that will explode or ignite in the presence of an ignition source. UEL - the highest percent of vapor in air, by volume, that will explode or ignite in the presence of an ignition source.

TOXICOLOGICAL INFORMATION:

Possible health hazards as derived from human data, animal studies, or from the results of studies with similar compounds are presented. Definitions of some terms used in this section are: **LD₅₀** - Lethal Dose (solids & liquids) which kills 50% of the exposed animals; **LC₅₀** - Lethal Concentration (gases) which kills 50% of the exposed animals; **ppm** concentration expressed in parts of material per million parts of air or water; **mg/m³** concentration expressed in weight of substance per volume of air; **mg/kg** quantity of material, by weight, administered to a test subject, based on their body weight in kg. Data from several sources are used to evaluate the cancer-causing potential of the material. The sources are: **IARC** - the International Agency for Research on Cancer; **NTP** - the National Toxicology Program, **RTECS** - the Registry of Toxic Effects of Chemical Substances, **OSHA** and **CAL/OSHA**. IARC and NTP rate chemicals on a scale of decreasing potential to cause human cancer with rankings from 1 to 4. Subrankings (2A, 2B, etc.) are also used. Other measures of toxicity include **TDLo**, the lowest dose to cause a symptom and **TCLo** the lowest concentration to cause a symptom; **TDo**, **LDLo**, and **LDo**, or **TC**, **TCo**, **LCLo**, and **LCo**, the lowest dose (or concentration) to cause lethal or toxic effects. **BEI** - Biological Exposure Indices, represent the levels of determinants which are most likely to be observed in specimens collected from a healthy worker who has been exposed to chemicals to the same extent as a worker with inhalation exposure to the TLV. Ecological Information: EC is the effect concentration in water.

REGULATORY INFORMATION:

U.S. and CANADA: This section explains the impact of various laws and regulations on the material. **EPA** is the U.S. Environmental Protection Agency. **WHMIS** is the Canadian Workplace Hazardous Materials Information System. **DOT** and **TC** are the U.S. Department of Transportation and the Transport Canada, respectively. Superfund Amendments and Reauthorization Act (**SARA**); the Canadian Domestic/Non-Domestic Substances List (**DSL/NDSL**); the U.S. Toxic Substance Control Act (**TSCA**); Marine Pollutant status according to the **DOT**; the Comprehensive Environmental Response, Compensation, and Liability Act (**CERCLA** or **Superfund**); and various state regulations. This section also includes information on the precautionary warnings which appear on the material's package label.

EUROPEAN: **EC** is the European Community (formerly known as the **EEC**, European Economic Community). **EINECS**: This is the European Inventory of Now-Existing Chemical Substances. The **ARD** is the European Agreement Concerning the International Carriage of Dangerous Goods by Road and the **RID** are the International Regulations Concerning the Carriage of Dangerous Goods by Rail.