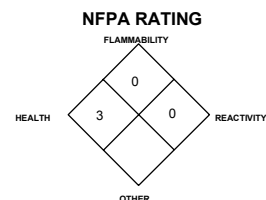
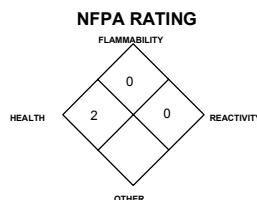
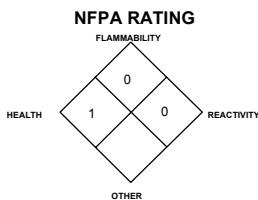




CARBON DIOXIDE GAS

CARBON DIOXIDE SOLID

CARBON DIOXIDE LIQUEFIED



MATERIAL SAFETY DATA SHEET

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

PART I *What is the material and what do I need to know in an emergency?*

1. PRODUCT IDENTIFICATION

CHEMICAL NAME; CLASS: **CARBON DIOXIDE - CO₂, GASEOUS**
CARBON DIOXIDE - CO₂, CRYOGENIC
CARBON DIOXIDE - CO₂, SOLID
 Document Number: 001013

PRODUCT USE: For general analytical/synthetic chemical uses.

SUPPLIER/MANUFACTURER'S NAME: AIRGAS INC.
ADDRESS: 259 N. Radnor Chester Road
 Suite 100
 Radnor, PA 19087-5283

BUSINESS PHONE: 1-610-687-5253
EMERGENCY PHONE: 1-800-949-7937
 International: 1-423-479-0293

DATE OF PREPARATION: May 20, 1996
DATE OF REVISION: August 3, 2002

2. COMPOSITION and INFORMATION ON INGREDIENTS

| CHEMICAL NAME | CAS # | mole % | EXPOSURE LIMITS IN AIR | | | | | |
|--------------------|----------|--------|--|----------|-----------------------------------|---------------------------|----------|---|
| | | | ACGIH | | OSHA | | IDLH ppm | OTHER ppm |
| | | | TLV ppm | STEL ppm | PEL ppm | STEL ppm | | |
| Carbon Dioxide | 124-38-9 | > 99.8 | 5000 | 30,000 | 5000 10,000 (Vacated 1989 PEL) | 30,000 (Vacated 1989 PEL) | 40,000 | DFG-MAK: 5000 NIOSH REL TWA: 5000 ST: 30000 ppm |
| Maximum Impurities | | < 0.2 | None of the trace impurities in this mixture contribute significantly to the hazards associated with the product. All hazard information pertinent to this product has been provided in this Material Safety Data Sheet, per the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200) and State equivalent standards. | | | | | |

NE = Not Established

C = Ceiling Limit.

See Section 16 for Definitions of Terms Used.



NOTE: All WHMIS required information is included. It is located in appropriate sections based on the ANSI Z400.1-1993 format.

3. HAZARD IDENTIFICATION



Carbon Dioxide Gas and Cryogenic Liquid

EMERGENCY OVERVIEW: Carbon Dioxide is a colorless gas, or a colorless, cryogenic liquid. At low concentrations, both the gas and the liquid are odorless. At higher concentrations Carbon Dioxide will have a sharp, acidic odor. At concentrations between 2 and 10%, Carbon Dioxide can cause nausea, dizziness, headache, mental confusion, increased blood pressure and respiratory rate. If the gas concentration reaches 10% or more, suffocation and death can occur within minutes. Contact with the cold gas can cause freezing of exposed tissue. Moisture in the air could lead to the formation of carbonic acid that can be irritating to the eyes. All forms of Carbon Dioxide are non-combustible. Carbon Dioxide is heavier than air and should not be allowed to accumulate in low lying areas.

CARBON DIOXIDE GAS

| HAZARDOUS MATERIAL INFORMATION SYSTEM | | | |
|---|---------------|---|---------------|
| HEALTH | (BLUE) | 1 | |
| FLAMMABILITY | (RED) | 0 | |
| REACTIVITY | (YELLOW) | 0 | |
| PROTECTIVE EQUIPMENT | | | B |
| EYES | RESPIRATORY | HANDS | BODY |
|  | See Section 8 |  | See Section 8 |
| For routine industrial applications | | | |

CARBON DIOXIDE LIQUEFIED

| HAZARDOUS MATERIAL INFORMATION SYSTEM | | | |
|---|---------------|---|---------------|
| HEALTH | (BLUE) | 3 | |
| FLAMMABILITY | (RED) | 0 | |
| REACTIVITY | (YELLOW) | 0 | |
| PROTECTIVE EQUIPMENT | | | X |
| EYES | RESPIRATORY | HANDS | BODY |
|  | See Section 8 |  | See Section 8 |
| For routine industrial applications | | | |

See Section 16 for Definition of Ratings

SYMPTOMS OF OVEREXPOSURE BY ROUTE OF EXPOSURE: The most significant route of overexposure for this gas is by inhalation. The following paragraphs describe symptoms of exposure by route of exposure.

INHALATION: Carbon Dioxide is an asphyxiant and a powerful cerebral vasodilator. If the concentration of Carbon Dioxide reaches 10% or more, suffocation can occur rapidly. Inhalation of concentrations between 2 and 10% can cause nausea, dizziness, headache, mental confusion, increased blood pressure and respiratory rate. Carbon Dioxide initially stimulates respiration and then causes respiratory depression. Inhalation of low concentrations (3-5%) have no known permanent harmful effects. Symptoms in humans at various levels of concentration are as follows:

| <u>CONCENTRATION</u> | <u>SYMPTOMS OF EXPOSURE</u> |
|----------------------|---|
| 1%: | Slight increase in breathing rate. |
| 2%: | Breathing rate increases to 50% above normal; 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 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. |

High concentrations of this gas can also cause an oxygen-deficient environment. However, the asphyxiating properties of Carbon Dioxide will be reached before oxygen-deficiency is a factor.

3. HAZARD IDENTIFICATION (Continued)

OTHER POTENTIAL HEALTH EFFECTS: 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. Contact of the cold gas with the eyes can cause pain, redness, burns, and severe exposure could cause blindness. Symptoms of frostbite include change in skin color to white or grayish-yellow. The pain after contact with cold gas can quickly subside. Moisture in the air could lead to the formation of carbonic acid, which can be irritating to the eyes.

HEALTH EFFECTS OR RISKS FROM EXPOSURE: An Explanation in **Lay Terms**. Overexposure to Carbon Dioxide may cause the following health effects:

ACUTE: Inhaling high concentrations of Carbon Dioxide can lead to coma or death. At low concentrations, inhalation of Carbon Dioxide can cause nausea, dizziness, visual disturbances, shaking, headache, mental confusion, sweating, increased heartbeat, and elevated blood pressure and respiratory rate. High concentrations of the gas in air may cause eye irritation or damage.

CHRONIC: Reversible effects on the acid-base balance in the blood, blood pressure, and circulatory system may occur after prolonged exposure to elevated Carbon Dioxide levels.

TARGET ORGANS: Respiratory system, cardiovascular system, eyes.

Carbon Dioxide Solid

EMERGENCY OVERVIEW: Solid Carbon Dioxide (dry ice), is a white, opaque solid which releases colorless, gas. This solid sublimates to gas quickly at standard temperatures and pressures, forming a fog in air. As a result, the main hazards associated with Carbon Dioxide are related to Carbon Dioxide gas formation and the cold temperature of the solid and evolved gas. At concentrations between 2 and 10%, Carbon Dioxide can cause nausea, dizziness, headache, mental confusion, increased blood pressure and respiratory rate. If the gas concentration reaches 10% or more, suffocation and death can occur within minutes. Contact with the solid 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. Carbon Dioxide is heavier than air and should not be allowed to accumulate in low lying areas.

SYMPTOMS OF OVEREXPOSURE BY ROUTE OF EXPOSURE: The most significant routes of overexposure for Carbon Dioxide are by inhalation of Carbon Dioxide gas, and skin or eye contact with the solid or gas. Symptoms of such exposure are as follows:



INHALATION: Carbon Dioxide is an asphyxiant and a powerful cerebral vasodilator. If the concentration of Carbon Dioxide reaches 10% or more, suffocation can occur rapidly. Inhalation of concentrations between 2 and 10% can cause nausea, dizziness, headache, mental confusion, increased blood pressure and respiratory rate. Carbon Dioxide initially stimulates respiration and then causes respiratory depression. Inhalation of low concentrations (3-5%) have no known permanent harmful effects. Symptoms in humans at various levels of concentration are as follows:

CONCENTRATION

SYMPTOMS OF EXPOSURE

| | |
|----------|--|
| 1%: | Slight increase in breathing rate. |
| 2%: | Breathing rate increases to 50% above normal; exposure causes 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; slight choking may be felt. |
| 5-10%: | Labored breathing, headache, visual impairment, ringing in the ears, impaired judgment, followed 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. |

CARBON DIOXIDE SOLID

| HAZARDOUS MATERIAL INFORMATION SYSTEM | | | |
|---|---------------|---|---------------|
| HEALTH | | (BLUE) | 2 |
| FLAMMABILITY | | (RED) | 0 |
| REACTIVITY | | (YELLOW) | 0 |
| PROTECTIVE EQUIPMENT | | | B |
| EYES | RESPIRATORY | HANDS | BODY |
|  | See Section 8 |  | See Section 8 |
| For routine industrial applications | | | |

See Section 16 for Definition of Ratings

3. HAZARD IDENTIFICATION (Continued)

INHALATION (Continued): High concentrations of this gas can also cause an oxygen-deficient environment. However, the asphyxiating properties of Carbon Dioxide will be reached before oxygen-deficiency is a factor.

OTHER POTENTIAL HEALTH EFFECTS: Contact with solid Carbon Dioxide can cause frostbite to skin, eyes, and other exposed tissue. Contact of the cold gas generated from the solid with the skin can lead to frostbite or dermatitis (red, cracked, irritated skin), depending upon concentration and duration of exposure. Contact of the cold gas with the eyes can cause pain, redness, burns, and severe exposure could cause blindness. Symptoms of frostbite include change in skin color to white or grayish-yellow. The pain after contact with cold gas or solid can quickly subside. Moisture in the air could lead to the formation of carbonic acid, which can be irritating to the eyes.

HEALTH EFFECTS OR RISKS FROM EXPOSURE: An Explanation in **Lay Terms**. Overexposure to Carbon Dioxide may cause the following health effects:

ACUTE: Contact with solid Carbon Dioxide or cold gas can cause frostbite to skin, eyes, and other exposed tissue. Carbon Dioxide gas evolved from the sublimation of the solid is an asphyxiant and a powerful cerebral vasodilator. Inhaling high concentrations of Carbon Dioxide can lead to coma or death. At low concentrations, inhalation of Carbon Dioxide can cause nausea, dizziness, visual disturbances, shaking, headache, mental confusion, sweating, increased heartbeat, and elevated blood pressure and respiratory rate. High concentrations of the gas in air may cause eye irritation or damage.

CHRONIC: There are currently no known adverse health effects associated with chronic exposure to solid Carbon Dioxide or the gas which is generated by sublimation.

TARGET ORGANS: Respiratory system, cardiovascular system, eyes.

PART III *How can I prevent hazardous situations from occurring?*

4. FIRST-AID MEASURES

RESCUERS SHOULD NOT ATTEMPT TO RETRIEVE VICTIMS OF EXPOSURE TO THIS PRODUCT WITHOUT ADEQUATE PERSONAL PROTECTIVE EQUIPMENT. At a minimum, Self-Contained Breathing Apparatus should be worn.

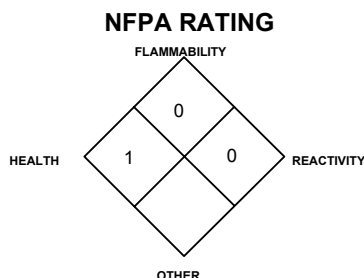
Remove victim(s) to fresh air, as quickly as possible. Trained personnel should administer supplemental oxygen and/or cardio-pulmonary resuscitation, if necessary. Only trained personnel should administer supplemental oxygen.

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.

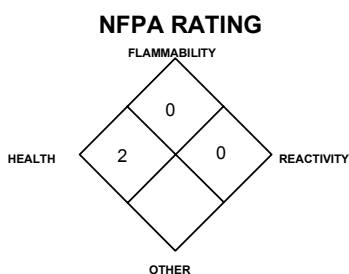
Victim(s) must be taken for medical attention. Rescuers should be taken for medical attention, if necessary. Take copy of label and MSDS to physician or other health professional with victim(s).

5. FIRE-FIGHTING MEASURES

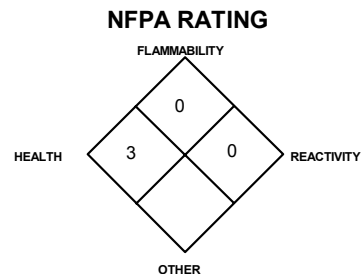
CARBON DIOXIDE GAS



CARBON DIOXIDE SOLID



CARBON DIOXIDE LIQUEFIED



See Section 16 for Definition of Ratings

FLASH POINT: Not Applicable.

AUTOIGNITION TEMPERATURE: Not Applicable.

FLAMMABLE LIMITS (in air by volume, %): Lower: Not Applicable.
Upper: Not Applicable.

5. FIRE-FIGHTING MEASURES (Continued)

FIRE EXTINGUISHING MATERIALS: Carbon Dioxide is commonly used as an extinguishing agent, and therefore, should not present a problem when trying to control a blaze. Use extinguishing media appropriate for surrounding fire.

UNUSUAL FIRE AND EXPLOSION HAZARDS: 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, zirconium, titanium alloys), are readily ignited and explode in the presence of Carbon Dioxide. Mixtures of solid Carbon Dioxide with sodium and potassium alloys are impact sensitive and explode violently. In the presence of moisture, cesium oxide ignites on contact with Carbon Dioxide. Metal acetylides or hydrides will also ignite or explode.

Explosion Sensitivity to Mechanical Impact: Not sensitive, except as noted above.

Explosion Sensitivity to Static Discharge: Not Sensitive.

SPECIAL FIRE-FIGHTING PROCEDURES: Structural fire-fighters must wear Self-Contained Breathing Apparatus and full protective equipment. Move fire-exposed cylinders if it can be done without risk to firefighters. Otherwise, cool containers with hose stream and protect personnel. Withdraw immediately in case of rising sounds from venting safety device or any discoloration of tanks due to the fire.

6. ACCIDENTAL RELEASE MEASURES

SPILL AND LEAK RESPONSE: Uncontrolled releases should be responded to by trained personnel using pre-planned procedures. Proper protective equipment should be used. In case of a spill, clear the affected area and protect people. Minimum Personal Protective Equipment should be **Level B: protective clothing, mechanically-resistant gloves and Self-Contained Breathing Apparatus**. Locate and seal the source of the leaking gas.

Allow the gas, which is heavier than air, to dissipate. Monitor the surrounding area for Carbon Dioxide and Oxygen levels. Colorimetric tubes are available for Carbon Dioxide. The levels of Carbon Dioxide must be below those listed in Section 2 (Composition and Information on Ingredients) and the atmosphere must have at least 19.5 percent Oxygen before personnel can be allowed in the area without Self-Contained Breathing Apparatus. Attempt to close the main source valve prior to entering the area. If this does not stop the release (or if it is not possible to reach the valve), allow the gas to release in-place or remove it to a safe area and allow the gas to be released there.

RESPONSE TO LIQUID RELEASE: Releasing liquid will immediately turn to dry ice. Clear the affected area and allow the solid to evaporate and the gas to dissipate. Clean up the solid as detailed below. After the gas is formed, follow the instructions provided in the previous paragraph. If the area must be entered by emergency personnel, SCBA, Kevlar gloves, and appropriate foot and leg protection must be worn.

RESPONSE TO SOLID RELEASE: Pick-up and immediately place solid pieces of dry ice in an appropriate, thermally-insulated, vented container. Alternatively, allow the solid to sublime and the gas that is generated to dissipate.

PART III *How can I prevent hazardous situations from occurring?*

7. HANDLING and STORAGE

WORK PRACTICES AND HYGIENE PRACTICES: As with all chemicals, avoid getting Carbon Dioxide IN YOU. Do not eat or drink while handling chemicals. Be aware of any signs of dizziness, fatigue, or any exposure symptom described in Section 3 (Hazard Identification); exposures to fatal concentrations of Carbon Dioxide could occur without any significant warning symptoms.

STORAGE AND HANDLING PRACTICES: Cylinders should be stored in dry, well-ventilated areas away from sources of heat. Containers of Carbon Dioxide can present significant safety hazards. Store containers away from heavily trafficked areas and emergency exits. Store containers away from process and production areas, away from elevators, building and room exits or main aisles leading to exits. Containers should be stored in dry, well-ventilated areas away from sources of heat, ignition and direct sunlight. Protect containers against physical damage. Isolate from other non-compatible chemicals (refer to Section 10, Stability and Reactivity).

SPECIAL PRECAUTIONS FOR HANDLING GAS CYLINDERS: Protect cylinders against physical damage. Store in cool, dry, well-ventilated, fireproof area, away from flammable materials and corrosive atmospheres. Store away from heat and ignition sources and out of direct sunlight. Do not store near elevators, corridors or loading docks. Do not allow area where cylinders are stored to exceed 52°C (125°F). Use only storage containers and equipment (pipes, valves, fittings to relieve pressure, etc.) designed for the storage of Solid, Gaseous or Liquefied Carbon Dioxide. Do not store containers where they can come into contact with moisture.

7. HANDLING and STORAGE (Continued)

SPECIAL PRECAUTIONS FOR HANDLING GAS CYLINDERS (Continued): Cylinders should be stored upright and be firmly secured to prevent falling or being knocked over. Cylinders can be stored in the open, but in such cases, should be protected against extremes of weather and from the dampness of the ground to prevent rusting. Never tamper with pressure relief devices in valves and cylinders. Liquefied Carbon Dioxide must be stored and handled under positive pressure or in a closed system to prevent the infiltration and solidification of air or other gases. The following rules are applicable to situations in which cylinders are being used :

Before Use: Move cylinders with a suitable hand-truck. Do not drag, slide or roll cylinders. Do not drop cylinders or permit them to strike each other. Secure cylinders firmly. Leave the valve protection cap in-place (where provided) until cylinder is ready for use.

During Use: Use designated CGA fittings and other support equipment. Do not use adapters. Do not heat cylinder by any means to increase the discharge rate of the product from the cylinder. Use check valve or trap in discharge line to prevent hazardous backflow into the cylinder. Do not use oils or grease on gas-handling fittings or equipment.

After Use: Close main cylinder valve. Replace valve protection cap (where provided). Mark empty cylinders "EMPTY".

NOTE: Use only DOT or ASME code containers. In the event of an electrical discharge, Carbon Dioxide gas will produce carbon monoxide and oxygen. Close valve after each use and when empty. Cylinders must not be recharged except by or with the consent of owner.

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 that 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.

SPECIAL PRECAUTIONS FOR HANDLING OF SOLID CARBON DIOXIDE: Do not handle solid Carbon Dioxide with bare hands. Use heavy gloves or dry ice tongs. Handle blocks of dry ice carefully, as injuries can occur if one is accidentally dropped on the feet. Never store dry ice in a standard refrigerator, cooler, or freezer designed for food storage. Containers of solid Carbon Dioxide should be stored upright and be firmly secured to prevent falling or being knocked-over. Containers should be vented, to prevent the build-up of Carbon Dioxide gas. Carbon Dioxide sublimates at -78.5°C (-109.3°F); containers should be thermally insulated and kept at the lowest possible temperature to maintain the solid and avoid generation of Carbon Dioxide gas. Storage containers and equipment used with Carbon Dioxide should not be located in sub-surface or enclosed areas, unless engineered to maintain a concentration of Carbon dioxide below the TLV (TLV = 5000 ppm in the event of a release. Solid consignment of dry ice in a gas-tight vessel can lead to catastrophic failure of the vessel by over-pressurization. Storage of dry ice should never occur in a gas-tight container.

PROTECTIVE PRACTICES DURING MAINTENANCE OF CONTAMINATED EQUIPMENT: Follow practices indicated in Section 6 (Accidental Release Measures). Make certain application equipment is locked and tagged-out safely. Purge gas handling equipment with inert gas (e.g., Nitrogen) before attempting repairs.

8. EXPOSURE CONTROLS - PERSONAL PROTECTION

VENTILATION AND ENGINEERING CONTROLS: Use with adequate ventilation. Carbon Dioxide accumulates in low-lying areas with limited air movement. Natural or mechanical ventilation should be available in the worker's breathing zone to prevent levels of Carbon Dioxide above exposure limits (see Section 2, Composition and Information on Ingredients). Local exhaust ventilation is preferred, because it prevents dispersion of this gas into the work place by eliminating it at its source. Areas of Carbon Dioxide use should be engineered to remove vapor from the lowest possible level and exhaust vapor to a well-ventilated area or to the outside. Carbon Dioxide levels should be monitored to assure levels are maintained below the TLV. If appropriate, install automatic monitoring equipment to detect the levels of Carbon Dioxide and of Oxygen.

RESPIRATORY PROTECTION: Maintain Carbon Dioxide levels below those listed in Section 2 (Composition and Information on Ingredients) and Oxygen levels above 19.5% in the workplace. Use supplied air respiratory protection if Carbon Dioxide levels are above the IDLH (40,000 ppm) or during emergency response to a release of this product. If respiratory protection is needed, use only protection authorized in the U.S. Federal OSHA Standard (29 CFR 1910.134), applicable U.S. State regulations, or the Canadian CSA Standard Z94.4-93 and applicable standards of Canadian Provinces. Oxygen levels below 19.5% are considered IDLH by OSHA. In such atmospheres, use of a full-facepiece pressure/demand SCBA or a full facepiece, supplied air respirator with auxiliary self-contained air supply is required under OSHA's Respiratory Protection Standard (1910.134-1998). The following are NIOSH respiratory protective equipment recommendations for Carbon Dioxide concentrations in air and are provided for further information:

| <u>CONCENTRATION</u> | <u>RESPIRATORY EQUIPMENT</u> |
|--|--|
| 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. |

EYE PROTECTION: Splash goggles, face-shields or safety glasses. Face-shields must be worn when using cryogenic Carbon Dioxide. If necessary, refer to U.S. OSHA 29 CFR 1910.133, or Canadian Standards.

HAND PROTECTION: Wear mechanically-resistant gloves when handling cylinders of Carbon Dioxide. Recommended use of low-temperature protective gloves (e.g. insulated polyvinyl chloride or insulated nitrile) when working with containers of Liquefied Carbon Dioxide. Wear thermally insulating gloves when handling Dry Ice.

BODY PROTECTION: Use body protection appropriate for task. Transfer of large quantities under pressure may require protective equipment appropriate to protect employees from splashes of liquefied product, as well provide sufficient insulation from extreme cold.

9. PHYSICAL and CHEMICAL PROPERTIES

GAS DENSITY @ 21°C (70°F) and 1 atm: 0.1144 lb/ft³ (1.833 kg/m³)

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

SOLID DENSITY @ -78.5°C (-109.3°F): 97.59 lb/ft³ (1569 kg/m³)

SPECIFIC GRAVITY (gas) @ 21°C (70°F): 1.52

SPECIFIC GRAVITY (solid) @ 0°C (32°F): 1.54

VAPOR PRESSURE (psia): 844.7

SOLUBILITY IN WATER @ 20°C (68°F): 0.90%

ODOR THRESHOLD: Not applicable.

EXPANSION RATIO: Not applicable.

BOILING POINT @ 1 atm (sublimation point): -78.5°C (-109.3°F)

COEFFICIENT WATER/OIL DISTRIBUTION: Not applicable.

EVAPORATION RATE (nBuAc = 1): Not applicable

FREEZING POINT: -56.6°C (-69.9°F)

SPECIFIC VOLUME (ft³/lb): 8.8

pH @ 1 atm: 3.7 (carbonic acid)

TRIPLE POINT @ 60.4 psig (416 kPa): -56.6°C (-69.9°F)

APPEARANCE AND COLOR: Carbon dioxide is a colorless to opaque, white solid; a colorless gas; or a colorless cryogenic liquid. All forms of Carbon Dioxide are odorless at low concentrations. At high concentrations, Carbon Dioxide will have a sharp, acidic odor.

HOW TO DETECT THIS SUBSTANCE (warning properties): The odor is not a good warning property, as the asphyxiation properties of Carbon Dioxide may present a hazard before the odor at high concentrations is readily detectable. In terms of leak detection for the gas, fittings and joints can be painted with a soap solution to detect leaks, which will be indicated by a bubble formation. In conditions of high humidity, the solid form of Carbon Dioxide may release visible vapors. Colorimetric tubes are available for the detection of Carbon Dioxide.

10. STABILITY and REACTIVITY

STABILITY: Normally stable.

DECOMPOSITION PRODUCTS: Carbon Dioxide gas in an electrical discharge yields carbon monoxide and oxygen. In the presence of moisture, Carbon Dioxide will form carbonic acid.

10. STABILITY and REACTIVITY (Continued)

MATERIALS WITH WHICH SUBSTANCE 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.

HAZARDOUS POLYMERIZATION: Will not occur, however Carbon Dioxide acts to catalyze the polymerization of acrylaldehyde and aziridine.

CONDITIONS TO AVOID: Avoid exposing cylinders of Carbon Dioxide to extremely high temperatures, which could cause the cylinders to rupture or burst. Do not store the solid form of Carbon Dioxide in gas-tight containers, which could also cause over-pressurization and rupture of the container.

PART IV *Is there any other useful information about this material?*

11. TOXICOLOGICAL INFORMATION

TOXICITY DATA: Carbon Dioxide is an asphyxiant gas, which has physiological effects at high concentrations. The following toxicological data are available for Carbon Dioxide.

CARBON DIOXIDE:

LCLo (Inhalation-Human) 9 pph/5 minutes
LCLo (Inhalation-Mammal-species unspecified) 90000 ppm/5 minutes
TCLo (Inhalation-Rat) 10000 ppm/24 hours/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-Rabbit) 27,000 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
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) 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)

CARBON DIOXIDE (continued):

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); Specific Developmental Abnormalities: musculoskeletal system

SUSPECTED CANCER AGENT: Carbon Dioxide is not found on the following lists: FEDERAL OSHA Z LIST, NTP, CAL/OSHA, IARC, and therefore is not considered to be, nor suspected to be a cancer-causing agent by these agencies.

IRRITANCY OF PRODUCT: Contact with rapidly expanding gases can cause frostbite and damage to exposed skin and eyes. Due to the formation of carbonic acid, this gas mixture can be slightly irritating to contaminated eyes.

SENSITIZATION OF PRODUCT: Carbon Dioxide is not a sensitizer after prolonged or repeated exposures.

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 has not been reported to cause embryotoxic effects; see next paragraph for information.

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 (e.g., cardiac and skeletal malformations, stillbirths).

Reproductive Toxicity: Carbon Dioxide is not expected to cause adverse reproductive effects in humans. Studies involving test animals exposed to high concentrations of Carbon Dioxide indicate reproductive effects (e.g. changes in testes).

*A **mutagen** is a chemical which causes permanent changes to genetic material (DNA) such that the changes will propagate through generation lines. An **embryotoxin** is a chemical which 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 which causes damage to a developing fetus, but the damage does not propagate across generational lines. A **reproductive toxin** is any substance which interferes in any way with the reproductive process.*

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Disorders involving the "Target Organs" (see Section 3, Hazard Information) may be aggravated by Carbon Dioxide overexposure.

RECOMMENDATIONS TO PHYSICIANS: Treat symptoms and reduce overexposure.

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

12. ECOLOGICAL INFORMATION

ENVIRONMENTAL STABILITY: Carbon Dioxide occurs naturally in the atmosphere. The gas will be dissipated rapidly in well-ventilated areas. The following environmental data are applicable to Carbon Dioxide.

CARBON DIOXIDE: Food chain concentration potential: None. Biological Oxygen Demand: None

EFFECT OF MATERIAL ON PLANTS or ANIMALS: Any adverse effect on animals would be related to Carbon Dioxide overexposure and oxygen-deficient environments. No adverse effect is anticipated to occur to plant-life, except for frost produced in the presence of rapidly expanding gases.

EFFECT OF CHEMICAL ON AQUATIC LIFE: The following aquatic toxicity data are available for Carbon Dioxide.

CARBON DIOXIDE:

Aquatic toxicity: 100-200 mg/l/no time specified/various organisms/fresh water.

Waterfowl toxicity: Inhalation 5-8%, no effect.

13. DISPOSAL CONSIDERATIONS

PREPARING WASTES FOR DISPOSAL: Product removed from cylinder must be disposed of in accordance with appropriate U.S. Federal, State and local regulations or with regulations of Canada and its Provinces. Return cylinders with residual product to Airgas, Inc. Do not dispose of locally.

14. TRANSPORTATION INFORMATION

THIS MATERIAL IS HAZARDOUS AS DEFINED BY 49 CFR 172.101 BY THE U.S. DEPARTMENT OF TRANSPORTATION.

For Carbon Dioxide Gas:

PROPER SHIPPING NAME: Carbon dioxide
HAZARD CLASS NUMBER and DESCRIPTION: 2.2 (Non-Flammable Gas)
UN IDENTIFICATION NUMBER: UN 1013
PACKING GROUP: Not applicable.
DOT LABEL(S) REQUIRED: Non-Flammable Gas
NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK NUMBER (2000): 120

For Carbon Dioxide Liquefied:

PROPER SHIPPING NAME: Carbon dioxide, refrigerated liquid
HAZARD CLASS NUMBER and DESCRIPTION: 2.2 (Non-Flammable Gas)
UN IDENTIFICATION NUMBER: UN 2187
PACKING GROUP: Not applicable.
DOT LABEL(S) REQUIRED: Non-Flammable Gas
NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK NUMBER (2000): 120

For Carbon Dioxide, Solid:

PROPER SHIPPING NAME: Carbon dioxide, solid or Dry ice
HAZARD CLASS NUMBER and DESCRIPTION: 9 (Miscellaneous Dangerous Goods)
UN IDENTIFICATION NUMBER: UN 1845
PACKING GROUP: III
DOT LABEL(S) REQUIRED: None
NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK NUMBER (2000): 120

MARINE POLLUTANT: Carbon Dioxide is not classified by the DOT as a Marine Pollutant (as defined by 49 CFR 172.101, Appendix B).

TRANSPORT CANADA TRANSPORTATION OF DANGEROUS GOODS REGULATIONS: THIS MATERIAL IS CONSIDERED AS DANGEROUS GOODS. Use the above information for the preparation of Canadian Shipments.

15. REGULATORY INFORMATION

U.S. SARA REPORTING REQUIREMENTS: Carbon Dioxide is not subject to the reporting requirements of Sections 302, 304 and 313 of Title III of the Superfund Amendments and Reauthorization Act.

U.S. SARA THRESHOLD PLANNING QUANTITY: There are no specific Threshold Planning Quantities for Carbon Dioxide (solid, gaseous or liquid form). The default Federal MSDS submission and inventory requirement filing threshold of 10,000 lbs (4,540 kg) therefore applies, per 40 CFR 370.20.

U.S. CERCLA REPORTABLE QUANTITY (RQ): Not applicable.

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

U.S. TSCA INVENTORY STATUS: Carbon Dioxide is on the TSCA Inventory.

OTHER U.S. FEDERAL REGULATIONS: Not applicable.

U.S. STATE REGULATORY INFORMATION: Carbon Dioxide is covered under the following specific State regulations:

Alaska - Designated Toxic and Hazardous Substances: Carbon Dioxide.

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

Florida - Substance List: Carbon Dioxide.

Illinois - Toxic Substance List: Carbon Dioxide.

Kansas - Section 302/313 List: No.

Massachusetts - Substance List: Carbon Dioxide.

Michigan - Critical Material Register: No.

Minnesota - List of Hazardous Substances: Carbon Dioxide.

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

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

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

Pennsylvania - Hazardous Substance List: Carbon Dioxide.

Rhode Island - Hazardous Substance List: Carbon Dioxide.

Texas - Hazardous Substance List: Carbon Dioxide.

West Virginia - Hazardous Substance List: Carbon Dioxide.

Wisconsin - Toxic and Hazardous Substances: Carbon Dioxide.

CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT (PROPOSITION 65): Carbon Dioxide is not on the California Proposition 65 lists.

LABELING:

CARBON DIOXIDE GAS:

CAUTION:

LIQUID AND GAS UNDER PRESSURE.
CAN CAUSE RAPID SUFFOCATION.
CAN INCREASE RESPIRATION AND HEART RATE.
MAY CAUSE FROSTBITE.
Avoid breathing gas.
Store and use with adequate ventilation.
Do not get liquid in eyes, on skin or clothing.
Cylinder temperature should not exceed 125°F (52°C).
Use equipment rated for cylinder pressure.
Close valve after each use and when empty.
Use in accordance with the Material Safety Data Sheet.
Suck-back into cylinder may cause rupture.
Always use a back flow preventative device in piping.

NOTE:

FIRST-AID:

IF INHALED, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.
IN CASE OF FROSTBITE, obtain immediate medical attention.
DO NOT REMOVE THIS PRODUCT LABEL.

CARBON DIOXIDE, LIQUEFIED:

WARNING:

ALWAYS KEEP CONTAINER IN UPRIGHT POSITION.
COLD LIQUID AND GAS UNDER PRESSURE.
CAN INCREASE RESPIRATION AND HEART RATE.
MAY CAUSE FROSTBITE.
Avoid breathing gas.
Store and use with adequate ventilation.
Do not get liquid in eyes, on skin or clothing.
For liquid withdrawal, wear face shield and gloves.
Do not drop. Use hand truck for container movement.
Close valve after each use and when empty.
Use in accordance with the Material Safety Data Sheet.

FIRST-AID:

IF INHALED, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.
IN CASE OF FROSTBITE, obtain medical treatment immediately.
DO NOT REMOVE THIS PRODUCT LABEL.

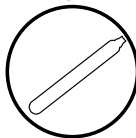
CARBON DIOXIDE, SOLID:

WARNING:

ALWAYS KEEP CONTAINER IN UPRIGHT POSITION.
EXTREMELY COLD SOLID THAT SUBLIMATES TO GAS RAPIDLY.
GAS CAN INCREASE RESPIRATION AND HEART RATE.
GAS CAN CAUSE RAPID SUFFOCATION.
CAN CAUSE FROSTBITE.
Avoid breathing gas.
Store and use with adequate ventilation.
Do not get solid in eyes, on skin or clothing.
For handling solid, wear face shield and gloves.
Use in accordance with the Material Safety Data Sheet.

FIRST-AID:

IF INHALED, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.
IN CASE OF FROSTBITE, obtain medical treatment immediately.
DO NOT REMOVE THIS PRODUCT LABEL.



16. OTHER INFORMATION

PREPARED BY:

Airgas – SAFECOR

The information contained herein is based on data considered accurate. However, no warranty is expressed or implied regarding the accuracy of these data or the results to be obtained from the use thereof. AIRGAS, Inc. assumes no responsibility for injury to the vendee or third persons proximately caused by the material if reasonable safety procedures are not adhered to as stipulated in the data sheet. Additionally, AIRGAS, Inc. assumes no responsibility for injury to vendee or third persons proximately caused by abnormal use of the material even if reasonable safety procedures are followed. Furthermore, vendee assumes the risk in his use of the material.

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, 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). **PERSONAL PROTECTIVE**

EQUIPMENT CODES: **B:** Gloves and goggles; **C:** Gloves, goggles, rubber apron (appropriate body protection); **D:** Gloves, goggles, faceshield; rubber apron (appropriate body protection);. **X:** Special attention should be given to PPE Selection.

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:

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.