

MATERIAL SAFETY DATA SHEET

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

1. PRODUCT IDENTIFICATION

CHEMICAL NAME; CLASS: NIROGEN/SILANE GAS MIXTURE

CHEMICAL FAMILY: Hydride/Inert Mixture

PRODUCT USE: Semiconductor Gas

MANUFACTURER

MATHESON TRI-GAS, INC.

959 ROUTE 46 EAST
PARSIPPANY, NJ 07054-0624
USA

Phone: 973/257-1100

EMERGENCY PHONE: **CHEMTREC (U.S. DOMESTIC):** **1-800-424-9300**
CHEMTREC INTERNATIONAL: **1-703-527-3887**
CANUTEC (CANADA): **1-613-996-6666**

2. COMPOSITION and INFORMATION ON INGREDIENTS

(10,000 ppm = 1%)

| CHEMICAL NAME | CAS # | mole % | EXPOSURE LIMITS IN AIR | | | | | |
|---------------|-----------|---------|---|-------------|------------|-------------|----------------------|--------------|
| | | | ACGIH-TLV | | OSHA-STEL | | NIOSH IDLH ppm | OTHER ppm |
| | | | TWA ppm | STEL ppm | TWA ppm | STEL ppm | | |
| Silane | 7803-62-5 | > 1-15% | 5 | NE | NE | NE | NE | TWA = 5 |
| Nitrogen | 7727-37-9 | Balance | There are no specific exposure limits for Nitrogen. Oxygen levels should be maintained above 19.5%. | | | | | |

NOTE: All WHMIS required information is included. It is located in appropriate sections based on the ANSI Z400.1-1998 format. This product has been classified in accordance with the hazard criteria of the CPR and the MSDS contains all the information required by the CPR.

See Section 16 for Definitions of Terms Used.

3. HAZARD IDENTIFICATION

EMERGENCY OVERVIEW: This is a colorless, highly-flammable gas mixture with a disagreeable odor. The main health hazard associated with releases of this gas mixture is the potential for severe thermal burns as the Silane component of this gas mixture ignites very readily. An additional health hazard may be asphyxiation by displacement of oxygen. Due to the presence of Silane, prolonged contact may be irritating to contaminated tissue. This gas mixture presents a serious fire hazard if accidentally released. Releases of this gas mixture will spread long distances; ignition or flash-back from a distance are possible. Flame or high temperature impinging on a localized area of the cylinder can cause cylinder to rupture violently or explosively. If this gas mixture is released at high pressure or high velocity, a hazard of delayed detonation may exist. Releases of this gas mixture that have not ignited must be considered extremely dangerous and should not be approached. Provide adequate fire protection during emergency response.

SYMPTOMS OF OVER-EXPOSURE BY ROUTE OF EXPOSURE: The most significant route of over-exposure for this product is by inhalation.

INHALATION: Prolonged contact via inhalation may be mildly irritating to the respiratory system due to the formation of silicic acid upon contact with moisture in the lungs. Symptoms may include coughing. Symptoms should be alleviated upon removal to fresh air. Although unlikely to occur, inhalation of high concentrations of this gas mixture may also result in headache and nausea. High concentrations of this gas mixture can cause an oxygen-deficient environment, especially if released in a poorly-ventilated area (e.g., an enclosed or confined space). Individuals breathing such an atmosphere may experience symptoms which include headaches, ringing in ears, dizziness, drowsiness, unconsciousness, nausea, vomiting, and depression of all the senses. Under some circumstances of overexposure, death may occur. The effects associated with various levels of oxygen are as follows:

CONCENTRATION OF OXYGEN

12-16% Oxygen:

10-14% Oxygen:

6-10% Oxygen:

Below 6%:

OBSERVED EFFECT

Breathing and pulse rate increase, muscular coordination slightly disturbed.

Emotional upset, abnormal fatigue, disturbed respiration.

Nausea, vomiting, collapse, or loss of consciousness.

Convulsive movements, possible respiratory collapse, and death.

It must be noted that the lower flammability limit of Silane may be met, causing fire, before an oxygen-deficient atmosphere may occur.

CONTACT WITH SKIN or EYES: The Silane component of this gas mixture may react with moisture in the air to form silicic acid, which may be irritating to the eyes. Contact with rapidly expanding gases (which are released under high pressure) may cause frostbite. Prolonged contact with this gas mixture may be mildly irritating to the skin and eyes.

SKIN ABSORPTION: No component of this gas mixture presents a hazard of skin absorption.

OTHER POTENTIAL HEALTH EFFECTS: The chief health hazard presented by this gas mixture is that it will ignite so rapidly, personnel in the area of a release can receive severe thermal burns.

HEALTH EFFECTS OR RISKS FROM EXPOSURE: Over-exposure to this gas mixture may cause the following health effects:

ACUTE: The primary health hazard associated with releases of this gas mixture is the potential for spontaneous ignition and thermal burns. Another significant hazard associated with this gas mixture is inhalation of oxygen-deficient atmospheres. Symptoms of oxygen deficiency include ringing in ears, headaches, shortness of breath, wheezing, dizziness, indigestion, and nausea. At high concentrations, unconsciousness or death may occur. Prolonged exposure may cause mild irritation, headache and nausea.

CHRONIC: There are currently no known adverse health effects associated with chronic exposure to this gas mixture.

TARGET ORGANS: ACUTE: Respiratory system, skin, eyes. CHRONIC: None known.

HMIS RATING: HEALTH = 1 FLAMMABILITY = 4 REACTIVITY = 0 PPE LEVEL = B

Hazard Scale: 0 = Minimal 1 = Slight 2 = Moderate 3 = Serious 4 = Severe PPE LEVEL B =

Goggles, gloves (leather for handling cylinders)

4. FIRST-AID MEASURES

GENERAL INFORMATION: Remove to fresh air, as quickly as possible. Only trained personnel should administer supplemental oxygen and/or cardio-pulmonary resuscitation, if necessary. **Seek medical attention immediately.**

SKIN EXPOSURE: If release of this gas mixture has resulted in frostbite, warm affected area slowly. Seek immediate medical attention.

EYE EXPOSURE: If release of this gas mixture has affected the eyes, seek immediate medical attention.

THERMAL BURNS: In event of thermal burns, trained personnel should provide first aid. Get medical attention immediately.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Pre-existing respiratory conditions may be aggravated by overexposure to this gas mixture.

5. FIRE-FIGHTING MEASURES

FLASH POINT: Not applicable for a flammable gas.

AUTOIGNITION TEMPERATURE: Not determined for mixture.

FLAMMABLE LIMITS (in air by volume, %): Not determined for mixture.

Lower (LEL): 1.4%

Upper (UEL): 96.0%

FIRE EXTINGUISHING MATERIALS: Extinguish fires of this gas mixture by shutting-off the source of gas. Do not use halocarbon-type fire extinguishing agents. Use water spray to cool fire-exposed structures and equipment.

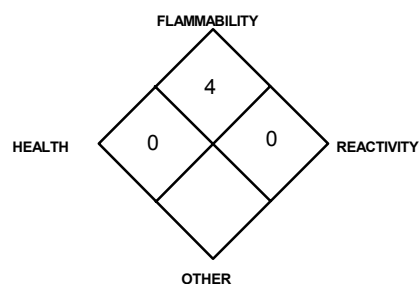
UNUSUAL FIRE AND EXPLOSION HAZARD: DANGER! This gas is extremely flammable and readily forms explosive mixtures with air over a very wide range. If released into a confined space, an extreme fire hazard exists. If this gas mixture is released at high pressure or high flow velocity, a delayed detonation may occur. Releases of this gas mixture which have not ignited must be considered to be extremely dangerous and should not be approached.

EXPLOSION SENSITIVITY TO MECHANICAL IMPACT: Not sensitive.

EXPLOSION SENSITIVITY TO STATIC DISCHARGE: Static discharge may cause this gas mixture to ignite explosively.

SPECIAL FIRE-FIGHTING PROCEDURES: Evacuate all personnel from danger area. Immediately cool cylinders with water spray from maximum distance, taking care to NOT extinguish flames if source of gas has not been stopped. Stop the leak and flow of gas before extinguishing fire. If release is still occurring, explosive re-ignition may occur. In event that fire is extinguished before the leak is stopped, attempt to increase ventilation to area to prevent formation of explosive air/gas mixtures. Incipient fire responders should wear eye protection. Structural fire fighters must wear Self-Contained Breathing Apparatus and full protective equipment. When cool, move cylinders from fire area if this can be done without risk to firefighters. Other information for pre-planning can be found in the American Petroleum Institute Publications 2510 and 1510A, and the North American Emergency Response Guidebook (Guide Number 115).

NFPA RATING



See Section 16 for Definition of Ratings

6. ACCIDENTAL RELEASE MEASURES

LEAK RESPONSE: Evacuate immediate area. Uncontrolled releases should be responded to by trained personnel using pre-planned procedures. Eliminate any possible source of ignition and provide maximum explosion-proof ventilation. Proper protective equipment, including fire protection, should be used in the event of a significant release from a single cylinder. Use only non-sparking tools. Call CHEMTREC (1-800-424-9300) for emergency assistance. Or if in Canada, call CANUTEC (613-996-6666).

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. Protect personnel attempting to shut-off with water spray. Monitor the surrounding area for combustible gas levels and the level of Oxygen. If this gas mixture is released at high pressure or high flow velocity, a delayed detonation may occur. Releases that have not ignited must be considered extremely dangerous and should not be approached.

The atmosphere must have not more than 10% of the LEL of the Silane component (see Section 5, Fire-Fighting Measures) and at least 19.5 percent Oxygen before non-emergency personnel can be allowed in the area without Self-Contained Breathing Apparatus and fire protection.

7. HANDLING and USE

WORK PRACTICES AND HYGIENE PRACTICES

Do not eat or drink while handling chemicals.

Be aware of all potential exposure symptoms; exposures to a fatal oxygen-deficient atmosphere 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.

Workers who handle this gas mixture should wear protective clothing, as listed in Section 8 (Exposure Controls and Personal Protection).

If ventilation controls are not adequate to provide sufficient oxygen content, proper respiratory protection equipment should be provided and workers using such equipment should be carefully trained in its operation and limitations.

Precautions must always be taken to prevent suck-back of foreign materials into the cylinder by using a check-valve, or vacuum break, since suck-back may cause dangerous pressure changes within the cylinder.

STORAGE AND HANDLING PRACTICES:

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. Cylinders should be stored in dry, well-ventilated areas away from sources of heat or ignition. Do not allow the area where cylinders are stored to exceed 52°C (125°F).

Cylinders should be separated from oxygen cylinders, or other oxidizers, by a minimum distance of 20 ft., or by a barrier of non-combustible material at least 5 ft. high, having a fire-resistance rating of at least 0.5 hours. Isolate from other incompatible chemicals (refer to Section 10, Stability and Reactivity). Storage areas must meet National Electrical Codes for Class 1 Hazardous Areas. Post "No Smoking or Open Flames" signs in storage or use areas. Consider leak detection and alarm for storage and use areas. Have appropriate extinguishing equipment in storage area (i.e. sprinkler system, portable fire extinguishers).

SPECIAL PRECAUTIONS FOR HANDLING GAS CYLINDERS: Compressed gases can present significant safety hazards. The following rules are applicable to work 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 (where provided) in-place until cylinder is ready for use.

7. HANDLING and USE (Continued)

SPECIAL PRECAUTIONS FOR HANDLING GAS CYLINDERS (Continued):

During Use: Use designated CGA fittings and other support equipment. Do not use adapters. Do not use oils or grease on gas-handling fittings or equipment. Immediately contact the supplier if there are any difficulties associated with operating the cylinder valve. Never insert an object (e.g wrench, screwdriver, pry bar, etc.) into valve cap openings. Doing so may damage the valve, causing a leak to occur. Use an adjustable strap wrench to remove over-tight or rusted caps. Never strike an arc, on a compressed gas cylinder or make a cylinder part of an electric circuit.

After Use: Close main cylinder valve. Replace valve protection cap. Close valve after each use and when empty. Mark empty cylinders "EMPTY".

SPECIAL PRECAUTIONS FOR HANDLING SILANE MIXTURES:

- Do not condense this gas mixture; avoid temperature of -100°C (-148°F) or less. Condensation of mixtures containing Silane run the risk of development of leaks due to the sucking back of air into the system, resulting in formation of explosive mixtures.
- Do not use this gas mixture in conjunction with heavy-metal halides or free halogens, with which the Silane component may react violently. Care should be taken that all handling systems are purged free of halogens that might exist from degreasing agents or chlorinated halogens.
- Evacuate and thoroughly pressure-check all systems, preferably with helium, for leaks at pressures two to three times the anticipated working pressure. A policy of regular leak-testing should be instituted and performed.
- Use and alternate vacuum and inert gas purge cycles of the system to purge all air of the system after it has been leak-tested or opened for any reason.
- Before disconnecting any system that has had a Silane mixture, thoroughly purge the system with an inert gas. Any portion of the system that is dead-ended or allows "pocketing" of this mixture should be treated with considerable vacuum-purge cycles.
- Vent this mixture through a small-diameter pipe or tubing ending under a shallow seal to prevent back diffusion of air. Venting should be to an area designed for proper disposal of a Silane mixture, preferably by burning. Concentrations, even in the low percentage range, are dangerous, and should not be exposed to air. This mixture may also be vented by diluting with additional inert gas to prevent ignition.

PROTECTIVE PRACTICES DURING MAINTENANCE OF CONTAMINATED EQUIPMENT: Refer to current CGA Guidelines for information on protective practices during maintenance of contaminated equipment.

8. EXPOSURE CONTROLS - PERSONAL PROTECTION

VENTILATION AND ENGINEERING CONTROLS: Use with adequate, explosion-proof ventilation to ensure compliance with exposure limits described in Section 2 (Composition and Information on Ingredients). Local exhaust ventilation is preferred, because it prevents dispersion of this gas mixture into the work place by eliminating it at its source. If appropriate, install automatic monitoring equipment to detect the level of Oxygen.

RESPIRATORY PROTECTION: Maintain the Oxygen level above 19.5% in the workplace. If necessary, use only respiratory protection authorized in the U.S. Federal OSHA Respiratory Protection Standard (29 CFR 1910.134), or equivalent U.S. State standards and Canadian CSA Standard Z94.4-93. 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).

EYE PROTECTION: Splash goggles or safety glasses. If necessary, refer to U.S. OSHA 29 CFR 1910.133, or appropriate Canadian Standards.

HAND PROTECTION: Wear mechanically-resistant gloves when handling cylinders containing this gas mixture. If necessary, refer to U.S. OSHA 29 CFR 1910.138, or appropriate Standards of Canada.

BODY PROTECTION: Use body protection appropriate for task. Transfer of large quantities under pressure may require protective equipment appropriate to the task. If a hazard of injury to the feet exists due to falling objects, rolling objects, foot protection should be used, as described in U.S. OSHA 29 CFR 1910.136.

9. PHYSICAL and CHEMICAL PROPERTIES

The following information is for Nitrogen, the main component of this gas mixture:

GAS DENSITY @ 0°C (32°F) and 1 atm: 0.072 lbs/cu ft (1.153 kg/m³)
FREEZING/MELTING POINT (@ 10 psig) -210°C (-345.8°F) **BOILING POINT:** -195.8°C (-320.4°F)
SPECIFIC GRAVITY (air = 1) @ 21.1°C (70°F): 0.906 **pH:** Not applicable.
SOLUBILITY IN WATER vol/vol at 0°C (32°F) and 1 atm: 0.023 **MOLECULAR WEIGHT:** 28.01
ODOR THRESHOLD: Not applicable. Odorless. **SPECIFIC VOLUME (ft³/lb):** 13.8
EVAPORATION RATE (nBuAc = 1): Not applicable.
EXPANSION RATIO: Not applicable.
VAPOR PRESSURE @ 21.1°C (70°F) psig: Not applicable.
COEFFICIENT WATER/OIL DISTRIBUTION: Not applicable.

The following information is pertinent to this product:

APPEARANCE, ODOR AND COLOR: This gas mixture is colorless, with a disagreeable odor.
HOW TO DETECT THIS SUBSTANCE (warning properties): There are no distinct warning properties of this gas mixture. In terms of leak detection, fittings and joints can be painted with a soap solution to detect leaks, which will be indicated by a bubble formation.

10. STABILITY and REACTIVITY

STABILITY: Stable at standard temperatures and pressures.

DECOMPOSITION PRODUCTS: The thermal decomposition products of this gas mixture are silicon oxides and hydrogen.

MATERIALS WITH WHICH SUBSTANCE IS INCOMPATIBLE: The Silane component is incompatible with halogens (bromine, chlorine, carbonyl chloride, antimony pentachloride, tin(IV) chloride), air, and water. The Nitrogen component is inert.

HAZARDOUS POLYMERIZATION: Will not occur.

CONDITIONS TO AVOID: Contact with incompatible materials. Cylinders exposed to high temperatures or direct flame can rupture or burst.

11. TOXICOLOGICAL INFORMATION

TOXICITY DATA: Nitrogen is a simple asphyxiant (SA), which acts to displace oxygen in the environment. No toxicity data are available for Nitrogen. The following data are for Silane:

LC₅₀ (Inhalation-Rat) 9600 ppm/4 hours
LC₅₀ (Inhalation-Mouse) 9600 ppm/4 hours

Mutation in Microorganisms (Bacteria-Salmonella typhimurium) 1 ppm

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

IRRITANCY OF PRODUCT: This gas mixture may be mildly irritating to contaminated tissue in the presence of moisture.

SENSITIZATION TO THE PRODUCT: The components of this product are not known to be skin or respiratory sensitizers.

REPRODUCTIVE TOXICITY INFORMATION: Listed below is information concerning the effects of the components of this gas mixture on the human reproductive system.

Mutagenicity: This gas mixture is not expected to cause mutagenic effects in humans. There are mutagenic data in microorganisms for the Silane component of this gas mixture.

Embryotoxicity: This gas mixture is not expected to cause embryotoxic effects in humans.

Teratogenicity: This gas mixture is not expected to cause teratogenic effects in humans.

Reproductive Toxicity: This gas mixture is not expected to cause adverse reproductive effects in humans.

BIOLOGICAL EXPOSURE INDICES (BEIs): Currently, there are no Biological Exposure Indices (BEIs) determined for the components of this gas mixture.

12. ECOLOGICAL INFORMATION

ENVIRONMENTAL STABILITY: This gas mixture will be dissipated rapidly in well-ventilated areas.

EFFECT OF MATERIAL ON PLANTS or ANIMALS: Any adverse effect on animals would be related to oxygen deficient environments.

EFFECT OF CHEMICAL ON AQUATIC LIFE: No an adverse effect from this gas mixture on aquatic life is expected.

13. DISPOSAL CONSIDERATIONS

PREPARING WASTES FOR DISPOSAL: Waste disposal must be in accordance with appropriate Federal, State, and local regulations. Return cylinders with any residual product to Matheson Tri-Gas. 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.

PROPER SHIPPING NAME: Compressed gases, flammable, n.o.s.
(Silane, Nitrogen)

HAZARD CLASS NUMBER and DESCRIPTION: 2.1 (Flammable Gas)

UN IDENTIFICATION NUMBER: UN 1954

PACKING GROUP: Not Applicable

D.O.T HAZARD LABEL: Flammable Gas

NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK NUMBER (2000): 115

MARINE POLLUTANT: The components of this gas mixture are not classified by the DOT as a Marine Pollutants (as defined by 49 CFR 172.101, Appendix B).

SPECIAL SHIPPING INFORMATION: Cylinders should be transported in a secure position, in a well-ventilated vehicle. The transportation of compressed gas cylinders in automobiles or in closed-body vehicles present serious safety hazards and should be discouraged.

NOTE: Shipment of compressed gas cylinders which have not been filled with the owner's consent is a violation of Federal law (49 CFR, Part 173.301 (b)).

TRANSPORT CANADA TRANSPORTATION OF DANGEROUS GOODS REGULATIONS: This gas mixture is considered as dangerous goods, per regulations of Transport Canada.

PROPER SHIPPING NAME: Compressed gases, flammable, n.o.s.
(Silane, Nitrogen)

HAZARD CLASS NUMBER and DESCRIPTION: 2.1 (Flammable Gas)

UN IDENTIFICATION NUMBER: UN 1954

PACKING GROUP: Not Applicable

HAZARD LABEL: Flammable Gas

NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK NUMBER (2000): 115

NOTE: Shipment of compressed gas cylinders via Public Passenger Road Vehicle is a violation of Canadian law (Transport Canada Transportation of Dangerous Goods Act, 1992).

15. REGULATORY INFORMATION

ADDITIONAL U.S. REGULATIONS:

U.S. SARA REPORTING REQUIREMENTS: No component of this product is 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 the components of this product. 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. SARA HAZARD CATEGORIES (SECTION 311/312, 40 CFR 370-21): ACUTE: Yes; CHRONIC: No; FIRE: Yes; REACTIVE: No; SUDDEN RELEASE: Yes

U.S. TSCA INVENTORY STATUS: Components of this product are listed on the TSCA Inventory.

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

OTHER U.S. FEDERAL REGULATIONS: Silane is subject to the reporting requirements of Section 112(r) of the Clean Air Act. The threshold quantity for this gas is 10,000 lbs (4,540 kg). Silane is listed as Regulated Substances in quantities of 10,000 lbs (4,540 kg) or greater, per 40 CFR, Part 68 of the Risk Management for Chemical Accidental Release.

U.S. STATE REGULATORY INFORMATION: Components of this product are covered under some specific State regulations, as denoted below (other State regulatory lists may exist; individual States should be contacted regarding full compliance).

California - Permissible Exposure Limits for Chemical Contaminants: Silane, Nitrogen.

New Jersey - Right to Know Hazardous Substance List: Silane, Nitrogen.

Pennsylvania - Hazardous Substance List: Silane, Nitrogen.

CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT (PROPOSITION 65): No component of this product is on the California Proposition 65 lists.

LABELING: Cylinders of this gas mixture should be labeled for precautionary information per the guidelines of the CGA. Refer to the CGA for further information.

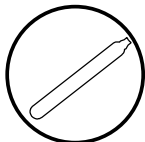
ADDITIONAL CANADIAN REGULATIONS:

CANADIAN DSL/NDL INVENTORY STATUS: The components of this product are listed on the DSL Inventory.

OTHER CANADIAN REGULATIONS: Not applicable.

CANADIAN ENVIRONMENTAL PROTECTION ACT (CEPA) PRIORITIES SUBSTANCES LISTS: The components of this product are not on the CEPA Priorities Substances Lists.

CANADIAN WHMIS SYMBOLS: This gas mixture would be categorized as a Controlled Product, Hazard Classes: **A** (compressed gas) and **F** (flammable). The following symbol is required for WHMIS compliance for this gas mixture.



16. OTHER INFORMATION

CREATION DATE: June 22, 2001

REVISION DATE: April 11, 2002

REVISION HISTORY: Up-date of manufacturer address and phone.

MIXTURES: When two or more gases or liquefied gases are mixed, their hazardous properties may combine to create additional, unexpected hazards. Obtain and evaluate the safety information for each component before you use the mixture. Consult an Industrial Hygienist or other trained person when you make your safety evaluation of the end product. Remember, gases and liquids have properties which can cause serious injury or death.

Further information can be found in the following pamphlets published by: Compressed Gas Association Inc. (CGA), 1725 Jefferson Davis Highway, Suite 1004, Arlington, VA 22202-4102. Telephone: (703) 412-0900.

"Safe Handling of Compressed Gases in Containers" (P-1, 1999)

"Safe Handling and Storage of Compressed Gases" (AV-1, 1999)

"Handbook of Compressed Gases" (1992)

PREPARED BY:

CHEMICAL SAFETY ASSOCIATES, Inc.
PO Box 3519, La Mesa, CA 91944-3519
800/441-3365

16. OTHER INFORMATION (Continued)

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.

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: This rating system was developed by the National Paint and Coating Association and has been adopted by industry to identify the degree of chemical hazards. **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). PPE Rating B: Hand and eye protection is required for routine chemical use.

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:

Human and Animal Toxicology: Possible health hazards as derived from select 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. Other measures of toxicity include **TDLo**, the lowest dose to cause a symptom and **TCLo** the lowest concentration to cause a symptom; **TD₀₁**, **LDLo**, and **LD₀₁**, or **TC**, **TC₀₁**, **LCLo**, and **LCo**, the lowest dose (or concentration) to cause lethal or toxic effects. **Cancer Information:** 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 Information:** **BEI** - ACGIH 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. **BCF** = Bioconcentration Factor, which is used to determine if a substance will concentrate in lifeforms which consume contaminated plant or animal matter. **TL_m** = median threshold limit; Coefficient of Oil/Water Distribution is represented by **log K_{ow}** or **log K_{oc}** and is used to assess a substance's behavior in the environment.

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/NDL**); 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.