



# MATERIAL SAFETY DATA SHEET

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

## SECTION 1. PRODUCT IDENTIFICATION

**PRODUCT NAME:** FLUORINE  
**CHEMICAL NAME:** Fluorine  
**FORMULA:** Fluorine = F<sub>2</sub>  
**SYNONYMS:** Not Applicable

**MANUFACTURER:** SPECTRA GASES, INC.  
**ADDRESS:** 3434 Route 22 West  
 Branchburg, NJ 08876, U.S.A.  
**PHONE:** 908/252-9300  
**FAX:** 908/252-0811  
**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, 202/484-7616

**DATE OF PREPARATION:** July 6, 1999

**MSDS NUMBER:** 1011

**PRODUCT USE:** Various

## SECTION 2. COMPOSITION and INFORMATION ON INGREDIENTS

**COMPOSITION:** Fluorine 100%  
**CAS NUMBER:** Fluorine 7782-41-4  
**EINECS NUMBER:** Fluorine 231-954-8  
**EXPOSURE LIMITS:** (10,000 ppm = 1%)

OSHA PELs:	ACGIH TLVs:	NIOSH RELs:
TWA = 0.1 ppm	TWA = 1 ppm STEL = 2 ppm	TWA = 0.1 ppm IDLH = 25 ppm

## SECTION 3. HAZARD IDENTIFICATION

**EMERGENCY OVERVIEW:** This gas is a pale-yellow to greenish, corrosive, toxic, liquefied gas which is an extremely powerful oxidizer with a pungent odor. It is shipped in steel cylinders at approximately 400 psig pressure. **POISON:** Fluorine is a toxic gas (DOT ZONE A; LC<sub>50</sub> = 185 ppm). Its corrosive action can burn lungs, skin and eyes. Evacuate in leak situation. Fluorine has a low odor threshold and provides a good warning of a release. Get immediate medical assistance in case of overexposure. **FIRE:** Fluorine is the most powerful oxidizing material known and will react with nearly all organic and inorganic substances. Although not flammable, Fluorine will enhance burning rate and can cause spontaneous ignition of most materials. Thus, most Fluorine leaks result in immediate fire (Note: the cylinder valve itself can burn). The only way to extinguish a fluorine-fed fire is to stop the flow of gas. If this cannot be done quickly and safely, withdraw and allow fluorine to be depleted. Fluorine is heavier than air and pockets of this gas can accumulate in low-lying areas. Persons responding to releases of this gas must protect themselves appropriately.

**ROUTES OF ENTRY, SYMPTOMS OF ACUTE EXPOSURE: WARNING** - If rescue personnel need to enter an area suspected of having a toxic level of Fluorine, they should be equipped with Self-Contained Breathing Apparatus (SCBA), and, if available, a full-body, chemically resistant suit. Acute overexposure to this gas may cause the following health effects:

**EYE CONTACT:** Minor eye contact (5-10 ppm) with this gas will cause tearing and irritation, including swelling and redness as Fluorine is a lachrymator. Exposure of elevated concentration to the eyes can cause burns in seconds, possibly resulting in blindness. Release of a high-pressure gas may result in airborne objects.

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

**INHALATION:** Inhalation of Fluorine gas or vapors severely irritates or burns all tissues of the respiratory system. Inhalation to high concentrations of Fluorine can lead to symptoms such as coughing, labored breathing, sore throat, and in serious exposures, unconsciousness, chemical pneumonitis and pulmonary edema. Exposure to high concentrations for more than a brief time can lead to hypocalcemia (see "Other Health Effects" for more information). Inhalation of high concentrations of this gas may be fatal.

### SECTION 3. HAZARD IDENTIFICATION (Continued)

**SKIN CONTACT:** Direct contact can cause severe burns in seconds. Burns may not be immediately painful or visible. Depending on the nature of the exposure, the effects can be immediate or delayed. Subcutaneous tissues can be affected by over-exposure, causing tissues to become blanched and bloodless. Gangrene of affected areas may follow.

**OTHER HEALTH EFFECTS:** It is important to note that Fluorine may react with water or moist air to generate hydrofluoric acid solution or hydrogen fluoride gas, which can penetrate the skin, causing destruction of the deep tissue layers, including bone tissue. This damage can continue for days, as the fluoride ion reacts with calcium in skin and bone. If 20% or more of the body is contaminated with hydrofluoric acid, hypocalcemia (a life-threatening lowering of serum calcium in the body) may result.

**HMIS RATINGS:** HEALTH: = 4; FLAMMABILITY: = 0; REACTIVITY: = 4;

PPE: Level H (see Section 8, Exposure Controls/Personal protective Equipment)

**ROUTES OF ENTRY, SYMPTOMS OF CHRONIC EXPOSURE:**

**ROUTE OF ENTRY:** Inhalation

**TARGET ORGANS:** Respiratory System

**SYMPTOMS:** Repeated over-exposure to low levels of fluorine for extended periods of time (i.e. years or decades) may lead to persistent irritation, emphysema and erosion or mottling of teeth and a condition called fluorosis, which is a weakening and degeneration of bone structure.

**MEDICAL CONDITIONS AGGRAVATED BY OVEREXPOSURE:** Pre-existing dermatitis, other skin conditions, and respiratory disorders may be aggravated by over-exposure to this gas. Additionally, repeated over-exposure to low levels of fluorine for extended periods of time (i.e. years or decades) may aggravate dental problems, heart conditions, bone disorders, and eye problems.

**CARCINOGENICITY:** Fluorine 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 this gas contaminates the eyes, open victim's eyes while under gentle running water. Use sufficient force to open eyelids. Have victim "roll" eyes. Minimum flushing is for 15 minutes. Administer anesthetic eye drops after one minute of flushing if victim suffers from spasms to the eyes, in order to facilitate irrigation. In the event of a severe overexposure, victim should consult with 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. Direct mouth-to-mouth resuscitation is not recommended. In the event of severe, immediate effects or delayed symptoms which develops after exposure, victim should seek appropriate medical attention.

**SKIN CONTACT:** If this gas contaminates the skin, immediately begin decontamination with running water. Minimum flushing is for 15 minutes. If necessary, calcium gluconate gel can be applied to affected areas, (use appropriate gloves to avoid contamination). Remove exposed or contaminated clothing, taking care not to contaminate eyes. Victim should seek appropriate medical attention if symptoms persist.

**NOTES TO PHYSICIANS: For Inhalation Exposure:** Administer 100% oxygen at half-hour intervals for three to four hours for victims of minor inhalation exposure. For serious inhalation exposure, 100% oxygen administration should begin immediately, under positive pressure (<4 cm) for half-hour periods for at least six hours until breathing is easy and the color of the skin and mucous membranes is normal.

**For Skin Contact:** For skin contamination, all areas of exposure should be flushed with copious quantities of water, followed by an iced aqueous or alcoholic solution of 0.13% benzalkonium chloride, iced 70% alcohol, or an ice-cold saturated solution of magnesium sulfate. If the area of burn cannot be drenched or immersed in solution, apply cold compresses containing the materials of the solution. After the iced solution treatment, application of a paste of powdered magnesium oxide and glycerin should be administered. The paste should be applied daily for several days. The prevention of serious burns can be prevented by infiltration of the skin and subcutaneous tissues with a 10% calcium gluconate solution, along with a local anesthetic. Care should be taken to see that all medical personnel providing treatment wear chemically-impervious gloves. In cases of severe over-exposure (more than 160 cm<sup>2</sup>), there is a potential for hypocalcemia. Therefore, systemic administration of calcium gluconate may be necessary. Frequent monitoring of serum calcium, cardiac, renal, and hepatic functions is necessary.

**For Eye Contact:** Exposed eyes should be flushed for 15 minutes, and the following additional treatment be provided: Treat with a continuous drip of 1 percent calcium gluconate in normal, sterile saline. No oils or ointments should be used.

**For Inhalation Exposure:** Administer 2.5% calcium gluconate by nebulizer with patient in sitting position, if conscious.

## SECTION 5. FIRE FIGHTING MEASURES

**FLASH POINT:** Not Applicable  
**AUTOIGNITION:** Not Applicable  
**FLAMMABLE RANGE:** Not Applicable  
**NFPA RATINGS:**

HEALTH: = 4                      FLAMMABILITY: = 0  
 REACTIVITY: = 4                SPECIAL: Water Reactive

**EXTINGUISHING MEDIA:** This gas is non-flammable, but is highly oxidizing. Most extinguishing media will burn or otherwise react in contact with fluorine gas.

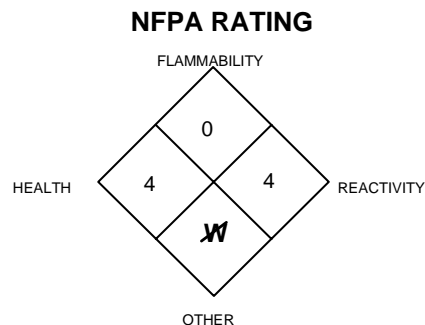
**SPECIAL FIRE-FIGHTING PROCEDURES:** If possible, stop flow of Fluorine to the fire. If possible, move cylinders not yet involved in a fire to safe area. Completely cool containers of this product with water spray to prevent failure.

**UNUSUAL FIRE AND EXPLOSION HAZARDS:** Releases of Fluorine presents a severe health inhalation hazard to firefighters. Fluorine can react with a wide range of organic and inorganic materials. Do not direct water directly onto a release of this gas, as Fluorine will react with water to product hydrofluoric acid solution. Cylinders containing Fluorine may not have a pressure relief device. Exposure to high heat, as in a fire situation, can cause the cylinder to rupture.

**EXPLOSION SENSITIVITY TO MECHANICAL IMPACT:** Not sensitive.

**EXPLOSION SENSITIVITY TO STATIC DISCHARGE:** Not sensitive.

**HAZARDOUS COMBUSTION PRODUCTS:** Fluorine will produce toxic combustion products including hydrogen fluoride and oxygen difluoride.



See Section 16 for  
Definition of Ratings

## SECTION 6. ACCIDENTAL RELEASE MEASURES

**STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED:** In the event of a leak of this product, operator should close the gas source if possible to do so safely. Evacuate immediate area. For large leak, the NAERG suggests 100 to 200 meters (330 to 660 feet) in all directions. Only trained personnel, wearing Self-Contained Breathing Apparatus (SCBA) and a chemically resistant suit should re-enter a contaminated area.

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 Fluorine should be below applicable exposure levels listed in Section 2 (Composition / Information on Ingredients) before personnel can be allowed in the area without SCBA. Detection systems may be considered to monitor for leaks and to measure the level of Fluorine.

## 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. Post "No Smoking or Open Flames" signs in storage or use areas. Cylinders of Fluorine should be stored away from organic or combustible materials. 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. Cylinders should be separated from flammable materials, 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. **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. Cylinder valves should be inspected regularly for physical damage or corrosion (apparent by discoloration or rust). Care should be taken to inspect the following valve locations for corrosion: neck (where valve inserts into cylinder); bonnet nut (where handle attaches to valve body).

**HANDLING:** Fluorine can be dangerous and should only be handled by trained personnel. Wearing contact lenses is not recommended when handling this gas. Spectra Gases, Inc., strongly recommends that this gas only be handled in areas with extensive venting capabilities, preferably a gas handling cabinet. Monitoring may be considered for areas in which this gas is used. Detection of Fluorine odor should trigger immediate response and corrective action. Contaminated clothing should be removed and laundered separately before reuse.

## SECTION 7. HANDLING AND STORAGE (Continued)

**HANDLING (continued):** Due to the strong oxidizing properties of Fluorine, cylinder valves should be operated remotely. In order to protect the operator, consider the use of an automatic remote valve actuator or valve handle extensions that passes through a steel barricade or other suitable material. **Before using this gas, meticulous leak checking using inert gas is strongly recommended, particularly after new connections are made.** Before introduction of Fluorine to a system, it should be purged with a dry, inert gas, such as helium or nitrogen. Fluorine-handling systems should be free of moisture, as Fluorine can corrode most metals in the presence of moisture. Systems that are contaminated with moisture may contain extremely corrosive hydrofluoric acid and so should always be kept under an inert atmosphere when not in use to prevent the introduction of moisture. Prior to use, any Fluorine-handling equipment must be thoroughly cleaned, solvent-rinsed and dried. The equipment should then be treated with increasing concentrations of Fluorine and/or pressures. This treatment allows Fluorine to react with and eliminate any impurities without igniting the system and provides a somewhat protective fluoride surface layer. Contact Spectra Gases for information on the proper passivation procedure.

Fluorine system valves should be operated slowly. The entire system should not be pressurized at once. Do not use rapidly opening valves, such as ball valves. Close valves securely after each use and when empty. When a Fluorine system is closed, the lines should again be purged with an inert gas.

Due to the potential for Fluorine to corrode most metals, only suitable materials should be used for construction. Appropriate materials are carbon steel, certain types of stainless steel and copper. Brass should be avoided. If high temperatures will be encountered in the system, nickel and monel are preferred. Lead is the preferred gasket material used in Fluorine systems.

Over time, Fluorine systems can become contaminated with a powder residue composed of metal fluorides and small amounts of hydrofluoric acid. This material is hazardous and should be treated with caution. A respirator, eye protection and gloves should be used.

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). Purge gas handling equipment with inert gas and relieve pressure before attempting repairs.

**SPECIAL PRECAUTIONS:** 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 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

**VENTILATION AND ENGINEERING CONTROLS:** Forced ventilation systems for the general work area should be provided. Spectra Gases, Inc. recommends that cylinders in use be secured within a ventilated enclosure such as a gas cabinet. Employee exposure should be monitored and reduced to the lowest practical levels using ventilation or other appropriate engineering controls.

**RESPIRATORY PROTECTION:** Maintain exposure levels of Fluorine below the levels listed in Section 2 (Composition / Information on Ingredients). Use supplied air respiratory protection if Fluorine levels exceed exposure limits, 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, standards of Canada, the European Standard EN149, and EC member states. The following guidelines, based on NIOSH respiratory protection recommendations, are for Fluorine.

<u>CONCENTRATION</u> of FLUORINE	<u>RESPIRATORY EQUIPMENT</u>
Up to 1 ppm	Supplied Air Respirator (SAR)
Up to 2.5 ppm	Supplied Air Respirator operated in continuous-flow mode.
Up to 5 ppm	Full-facepiece SCBA, or full-facepiece Supplied Air Respirator.
Up to 25 ppm	Positive-pressure, full-facepiece Supplied Air Respirator.

## SECTION 8. EXPOSURE CONTROLS / PERSONAL PROTECTION (Continued)

### RESPIRATORY PROTECTION (continued):

NIOSH Guidelines (continued):

#### CONCENTRATION of FLUORINE

#### RESPIRATORY EQUIPMENT

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

Escape Gas mask or mouth-piece respirator with acid gas cartridges or escape-type SCBA should be used.

**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. Use appropriate gloves for spill response.

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

## SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

**MOLECULAR WEIGHT:** 38.00

**GAS DENSITY @ 21.1°C (70°F):** 0.106 lb./ft<sup>3</sup> (1.70 kg/m<sup>3</sup>)

**VAPOR PRESSURE @ 20°C (68°F):** > 760 mm Hg

**BOILING POINT @ 1 atm:** -188.2°C (-306.8°F)

**FREEZING/MELTING POINT @ 1 atm:** -83.6°C (-118.43°F)

**SPECIFIC GRAVITY (air = 1) @ 21.1°C (70°F):** 1.858

**SOLUBILITY IN WATER @ 25°C (77°F):** 1.69

**SPECIFIC VOLUME @ 21.1°C (70°F):** 10.17 lb/ft<sup>3</sup> (0.635 m<sup>3</sup>/kg)

**CRITICAL PRESSURE:** 756.4 psia (5215 kPa abs)

**COEFFICIENT WATER/OIL DISTRIBUTION:** Not applicable.

**ODOR THRESHOLD:** 0.097-0.19 ppm (unspecified)

**APPEARANCE, ODOR AND STATE:** Pale yellow to greenish-colored gas with choking, pungent odor.

**WARNING PROPERTIES FOR THIS GAS:** The odor and its lachrymation properties can be distinctive warning properties associated with this gas. A leak of pure fluorine will usually cause a fire.

## SECTION 10. STABILITY AND REACTIVITY

**CHEMICAL STABILITY:** Fluorine reacts with water or moisture in the air to form hydrogen fluoride or hydrofluoric acid, plus small amounts of ozone, hydrogen peroxide and oxygen fluoride.

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

**MATERIALS WITH WHICH GAS IS INCOMPATIBLE:** Fluorine is not compatible with bases and can react violently. Fluorine is known to react with most oxidizable substances at room temperature. Fluorine forms fluorides with most elements. Fluorine can dissolve metals containing silica, and reacts with many other materials. This gas must be handled with care by appropriately trained and experienced personnel.

### REACTIVITY:

**A) HAZARDOUS DECOMPOSITION PRODUCTS:** Fluorine reacts with water or moisture in the air to form a mixture containing hydrogen fluoride or hydrofluoric acid, plus small amounts of ozone, hydrogen peroxide and oxygen fluoride.

**B) HAZARDOUS POLYMERIZATION:** Will not occur.

## SECTION 11. TOXICOLOGICAL INFORMATION

**TOXICITY DATA:** The following toxicological data are available for Fluorine.

Eye effects-Human 25 ppm/5 minutes: Mild irritation effects	LC <sub>50</sub> (Inhalation-Inhalation-Rat) 185 ppm/1 hour	LC (Inhalation-dog) >93 ppm/1 hour: Lungs, Thorax, or Respiration: cough: Lungs, Thorax, or Respiration: dyspnea: Gastrointestinal: nausea or vomiting
Eye effects-Rat 140 ppm/30 minutes	LC <sub>50</sub> (Inhalation-Mouse) 150 ppm/1 hour	
Eye effects-Mouse 467 ppm/5 minutes	LC <sub>50</sub> (Inhalation-Rabbit, adult) 270 ppm/30 minutes	
Eye effects-Dog, adult 68 ppm/1 hour	LC <sub>50</sub> (Inhalation-Guinea Pig, adult) 170 ppm/1 hour	Mutation in Microorganisms-Salmonella typhimurium 1 mg/plate

**CARCINOGENICITY:** Fluorine has not been found to be carcinogenic.

**IRRITANCY OF PRODUCT:** Fluorine is severely irritating to contaminated tissue.

**SENSITIZATION OF PRODUCT:** Fluorine is not a sensitizer.

## SECTION 11. TOXICOLOGICAL INFORMATION (Continued)

**REPRODUCTIVE TOXICITY INFORMATION:** Listed below is information concerning the Fluorine on the human reproductive system.

**Mutagenicity:** Fluorine has been reported to cause mutagenic effects in specific animal tissues during experimental studies with exposures at relatively high doses.

**Embryotoxicity:** Fluorine is not expected to cause embryotoxic effects in humans.

**Teratogenicity:** Fluorine is not expected to cause teratogenic effects in humans.

**Reproductive Toxicity:** Fluorine is not expected to cause adverse reproductive effects in humans.

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):** Biological Exposure Indices (BEIs) are applicable for Fluorine, as follows.

CHEMICAL DETERMINANT	SAMPLING TIME	BEI
FLUORIDES • Fluorides in urine	• Prior to shift • End of shift	• 3 mg/g creatinine • 10 mg/g creatinine

## SECTION 12. ECOLOGICAL INFORMATION

**ENVIRONMENTAL STABILITY:** In natural waters containing calcium and other alkali and alkaline earth metals, fluorine will precipitate out as calcium fluoride and other fluoride salts, and thus will naturally neutralize. Additionally, Fluorine reacts with water or moisture in the air to form a hydrogen fluoride or hydrofluoric acid. All work practices should be aimed at eliminating environmental contamination.

**EFFECT OF MATERIAL ON PLANTS or ANIMALS:** Due to the corrosive and toxic nature of this gas, animals exposed to this product will experience tissue damage, burns, and may be killed. Plants contaminated with this product may be adversely affected or destroyed. The following phytotoxicity data are available for Fluorine:

EC<sub>50</sub> (*Lemna minor* duckweed) 4 weeks = > 60,000 µg/L

**EFFECT OF CHEMICAL ON AQUATIC LIFE:** Fluorine can be detrimental to aquatic life. If a large release this gas occurs near a river or other body of water, there is a potential for fish and other aquatic life to be harmed or killed. The following aquatic toxicity data are currently available for Fluorine:

TLm (trout) time period not specified = 2.3 ppm (fresh water)

**MOBILITY:** Due to the reaction of Fluorine to hydrofluoric acid, it will not be mobile in soil.

**PERSISTENCE AND BIODEGRADABILITY:** Persistence: Fluorine will react to form hydrofluoric acid which will be dissipated by natural alkalinity. Biodegradation: Fluorine will biodegrade

**POTENTIAL TO BIOACCUMULATE:** No data are currently available on the bioaccumulation of Fluorine.

**OZONE-DEPLETION POTENTIAL:** Fluorine is not a Class I or Class II ozone depleting chemical (40 CFR Part 82).

## SECTION 13. DISPOSAL CONSIDERATIONS

**UNUSED PRODUCT / EMPTY CONTAINER:** Do not dispose of unused product. Return used 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:** Residual product in system can be neutralized using various caustic systems (e.g., activated alumina or soda lime). Neutralization should only be done by appropriately trained and experienced personnel. Disposal 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:

<b>U.S. DOT PROPER SHIPPING NAME:</b>	Fluorine, compressed
<b>HAZARD CLASS NUMBER and DESCRIPTION:</b>	2.3 (Toxic Gas)
<b>UN IDENTIFICATION NUMBER:</b>	UN 1045
<b>U.S. DOT SHIPPING LABEL(S) REQUIRED:</b>	Primary Hazard: Toxic Gas Subsidiary Hazard: Oxidizer Tertiary Hazard: Corrosive
<b>PLACARD (When required):</b>	Toxic Gas

## SECTION 14. TRANSPORT INFORMATION (Continued)

**U.S. SHIPPING INFORMATION (continued):**

**SPECIAL PROVISION:** Shipments of Fluorine must be described as "Poison Inhalation Hazard - ZONE A".

**SPECIAL SHIPPING INFORMATION:** Cylinders should be transported in a secure position in a well-ventilated truck (never transport in passenger compartment of a vehicle). 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) #: 124**

**CANADIAN SHIPPING INFORMATION:**

**TRANSPORT CANADA TRANSPORTATION OF DANGEROUS GOODS REGULATIONS:** This gas is considered as dangerous goods; use the above information for the preparation of Canadian Shipments. Note: Under Transport Canada regulations, Fluorine is given a primary hazard of toxic and a secondary hazard of oxidizer; no hazard of corrosivity is given. Shipments of this gas are also subject to Special Provision 102.

**INTERNATIONAL AIR TRANSPORT ASSOCIATION SHIPPING INFORMATION (IATA):**

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

**PROPER SHIPPING NAME:** Fluorine, compressed  
**HAZARD CLASS NUMBER and DESCRIPTION:** 2.3 (Toxic Gas)  
**UN IDENTIFICATION NUMBER:** UN 1045  
**HAZARD LABEL(S) REQUIRED:** Primary Hazard: Toxic Gas  
 Subsidiary Hazard: Oxidizer  
 Tertiary Hazard: Corrosive

The following Packaging Information is applicable to this product:

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				
FORBIDDEN! This commodity may be transported on passenger and on cargo aircraft, only with the prior approval of the appropriate authority of the State of origin under the written conditions established by the authority.					

**INTERNATIONAL MARITIME ORGANIZATION SHIPPING INFORMATION (IMO):**

**IMO DESIGNATION:** Fluorine is considered as dangerous goods, per the International Maritime Organization.

**PROPER SHIPPING NAME:** Fluorine, compressed  
**HAZARD CLASS NUMBER and DESCRIPTION:** 2.3 (Toxic Gas)  
**UN IDENTIFICATION NUMBER:** UN 1045  
**HAZARD LABEL(S) REQUIRED:** Primary Hazard: Toxic Gas  
 Subsidiary Hazard: Oxidizer  
 Tertiary Hazard: Corrosive  
**STOWAGE CATEGORY:** Category "D" - Clear of living quarters. Segregation as for Class 5.1, but "separated from" Class 7 materials.

**IMDG CODE:** Page 2142

**MARINE POLLUTANT:** Fluorine 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): NOTE:** Currently, Fluorine has not been officially listed as a part of the ADR. Fluorine has not been submitted either to the working Party on the Transport of Dangerous Goods of the Inland Transport Committee for checking and approval, nor to the Contracting parties to ADR for formal acceptance. Fluorine is listed in Supplement 1, which has the Name of substance, the Substance Identification, Class, and Item Number and Letter only. The following information is suggested shipping information. Persons shipping this gas must consult Annexes A and B and follow provisions of those annexes.

**SUBSTANCE IDENTIFICATION NO.:** 1045  
**NAME OF SUBSTANCE:** Fluorine, compressed  
**HAZARD IDENTIFICATION NO.:** These hazard identification numbers are not currently formally assigned by the ADR, but have been provided, based upon Appendix B.5 of the ADR:  
 265 (toxic gas, oxidizing) and 268 (toxic gas, corrosive)  
**LABEL:** 6.1 + 8 + 5.1  
**CLASS AND ITEM NUMBER:** 2, 1, TOC

<b>SECTION 15. REGULATORY INFORMATION</b>
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**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): Fluorine = 10 lb. (4.54 kg)

**SARA TITLE III:** Superfund Amendment and Reauthorization Act

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

Extremely Hazardous Substances: Fluorine is listed.

Threshold Planning Quantity (TPQ): Fluorine = 500 lb. (227.5 kg)

Reportable Quantity (RQ): Fluorine = 10 lb. (4.54 kg)

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

IMMEDIATE HEALTH: Yes

PRESSURE: Yes

DELAYED HEALTH: Yes

REACTIVITY: Yes

FIRE: No

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

Releases of Fluorine 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): Fluorine = 1000 lb. (454 kg)

**TSCA:** Toxic Substances Control Act

Fluorine 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): Fluorine = 1000 lb. (454 kg)

**U.S. STATE REGULATORY INFORMATION:**

**CALIFORNIA PROPOSITION 65:** Fluorine is not a listed substance for which the State of California requires warning under this statute.

Fluorine is covered under the following specific State regulations (more specific regulations exist in some States):

**Alaska - Designated Toxic and Hazardous Substances:** Fluorine.

**Minnesota - List of Hazardous Substances:** Fluorine.

**Pennsylvania - Hazardous Substance List:** Fluorine.

**California - Permissible Exposure Limits for Chemical Contaminants:** Fluorine.

**Missouri - Employer Information/Toxic Substance List:** Fluorine.

**Rhode Island - Hazardous Substance List:** Fluorine.

**Florida - Substance List:** Fluorine.

**New Jersey - Right to Know Hazardous Substance List:** Fluorine.

**Texas - Hazardous Substance List:** Fluorine.

**Illinois - Toxic Substance List:** Fluorine.

**North Dakota - List of Hazardous Chemicals, Reportable Quantities:** Fluorine.

**West Virginia - Hazardous Substance List:** Fluorine.

**Kansas - Section 302/313 List:** Fluorine.

**Massachusetts - Substance List:** Fluorine.

**Michigan - Critical Materials Register:** None.

**Wisconsin - Toxic and Hazardous Substances:** Fluorine.

**CANADIAN FEDERAL REGULATIONS:**

**CANADIAN DSL INVENTORY STATUS:** Fluorine is listed on the Canadian DSL Inventory.

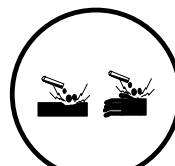
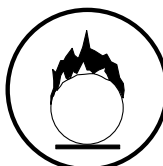
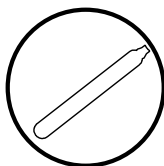
**OTHER CANADIAN REGULATIONS:** Fluorine would be categorized as a Controlled Product, Hazard Classes A, D1A, and E, as per the Controlled Product Regulations. Fluorine is on the CEPA Priorities Substances Lists. Fluorine (as an Inorganic Fluoride compound) would be on the First Priorities Substances List (Toxic).

**CANADIAN WHMIS SYMBOLS:** **Class A:** Compressed Gas

**Class D1A:** Toxic Material/Immediate and Serious Effects

**Class C:** Oxidizing Material

**Class E:** Corrosive Material



## SECTION 15. REGULATORY INFORMATION (Continued)

## EUROPEAN ECONOMIC COMMUNITY REGULATIONS:

## FLUORINE:

**EC EINECS/ELINCS NUMBER:** 231-954-8

**EC CLASSIFICATION:** Very Toxic; Very Toxic by Inhalation; May Cause Fire; Causes Severe Burns: [R 7; T+; C]

**EC RISK PHRASES:** May cause fire. Very toxic by inhalation. Causes severe burns. [R: 7, 26, 35]

**EC SAFETY PHRASES:** Keep locked up and out of the reach of children.\* *\*This safety phrase can be omitted from the label when the substance or preparation is sold for industrial use only.* Keep container tightly closed and in a well ventilated place. In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. Wear suitable protective clothing, gloves and eye/face protection. In case of accident or if you feel unwell, seek medical advice immediately (show label where possible). [S:(1/2)\*, 7/9, 26, 36/37/39, 45]

**EC COMMENTS:** In terms of Fluorine toxicity, use the following concentration limits:

$C \geq 10\%$ : Causes severe burns. [R: 35]

$7\% \leq C < 10\%$ : Very Toxic. [R: 26-35]

$5\% \leq C < 7\%$ : Toxic by inhalation. [R: 26-34]

$1\% \leq C < 5\%$ : Toxic. [R: 23-34]

$0.1\% \leq C < 1\%$ : Harmful. [R: 20]

## EUROPEAN COMMUNITY ANNEX II HAZARD SYMBOLS:



## SECTION 16. OTHER INFORMATION

Information contained in this Material Safety Data Sheet is provided to our customers so they may comply with 29 CFR 1910.1200, Hazard Communication Standard, the Canadian WHMIS Standard, and the requirements of the European Community Directives. The intent of this Material Safety Data Sheet is to provide end users of this product with the health and physical hazards associated with possible exposure to this product. All statements, technical data and recommendations are based on readily available texts and data that Spectra Gases, Inc., believes to be reliable and accurate. Spectra Gases, Inc., makes no warranties, guarantees or representations of any kind with respect to this product or this data. It is the responsibility of the user to obtain and use the most recent version of this MSDS.

Further information about compressed gases 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.

P-1 "Safe Handling of Compressed Gases in Containers"

AV-1 "Safe Handling and Storage of Compressed Gases"

"Handbook of Compressed Gases"

## PREPARED BY:

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## 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: **LD<sub>50</sub>** - Lethal Dose (solids & liquids) which kills 50% of the exposed animals; **LC<sub>50</sub>** - 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/m<sup>3</sup>** 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/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.

**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