Material Safety Data Sheet for:
Germane (GeH_4)

In an emergency, call CHEMTREC at 800-424-9300 or 703-527-3887.

Section 1: Chemical Product and Company Identification

Material Name: Germane. **Chemical Formula:** GeH_4.

Synonyms: Germanium hydride, germanium tetrahydride, monogermane, germanomethane.

Manufacturer: Voltaix, LLC: Post Office Box 5357, North Branch, New Jersey 08876-5357 USA
Voice: 908-231-9060 or 800-VOLTAIX, Facsimile: 908-231-9063

Section 2: Composition/Information on Ingredients

Component	CAS Registry Number	Molar (volume) concentration	Exposure Guidelines
Germane	7782-65-2	100%	0.2 ppm TLV-TWA (ACGIH)

Section 3: Hazards Identification

Emergency Overview

Germane is a colorless gas with a pungent odor that is not detectable by some people. Its immediate health hazards are that it is a poison gas and that its combustion may cause thermal burns. It is a flammable gas that may form mixtures with air that are flammable or explosive. Germane is reactive with oxidizers and halogens.

NFPA 704 Rating (NFPA 49-1991): Health 4 Fire 4 Reactivity 3 Special none

Potential Health Effects

Routes of Exposure: The primary route of exposure is inhalation.

Lengths of Exposure: Germane has been found in animal studies to be toxic in acute (1 hour) tests.

Severity of Effect: Depends on concentration and duration.

Target Organs: Germane is a hemolytic agent. Secondary renal and neurological damage has been observed.

Type of Effect: Respiratory irritation and impairment, pulmonary edema.

Signs and Symptoms of Exposure: shortness of breath, headache, nausea and vomiting, altered behavior, unconsciousness, muscle contraction.

Medical Conditions that may be Aggravated by Exposure: None identified.

Reported Carcinogenic and Reproductive Effects: NTP has not conducted studies on genetic toxicity, long term toxicology or carcinogenesis. No information on these effects is known to Voltaix

Section 4: First Aid Measures

Inhalation

This is the primary route of exposure.

1) Remove the affected person from the gas source or contaminated area. Note: Personal Protective Equipment (PPE), including positive pressure, self contained breathing apparatus, may be required to assure the safety of the rescuer.

2) If the affected person is not breathing spontaneously, administer rescue breathing.

3) If the affected person does not have a pulse, administer CPR.

4) If medical oxygen and appropriately trained personnel are available, administer 100% oxygen to the affected person.

5) Summon an emergency ambulance. If an ambulance is not available, contact a physician, hospital, or poison control center for instruction.

6) Keep the affected person warm, comfortable, and at rest while awaiting professional medical care. *Monitor the breathing and pulse continuously.* Administer rescue breathing or CPR if necessary.

Skin Contact

Flush with a copious stream of water while removing contaminated clothing. Continue flushing until the professional medical assistance arrives, but for no less than fifteen minutes. Assume the patient has also been exposed by inhalation and obtain professional medical assistance immediately. Treat thermal burns by flushing with cool water to assure that affected area is cool, then applying dry sterile dressings. If the patient is burned on the face, neck, head, or chest, assume that the airway may also have been burned and obtain professional medical assistance immediately.

Eye Contact

Flush continuously with clean water until the professional medical assistance arrives, but for no less than thirty minutes. Continuation of flushing until patient is transferred to an ophthalmologist or emergency physician is recommended.

Ingestion

Ingestion is not an observed route of exposure to gaseous hazardous materials.

Chronic Effects

None is known to Voltaix

Note to Physicians:

The effects of exposure to germane are similar to those of exposure to other hemolytic hydrides, such as arsine. Consider diuresis, hemodialysis, peritoneal dialysis and exchange transfusions.

Section 5: Fire Fighting Measures

Flammability and Explosivity

Flash Point: Not applicable, this material is a gas.

Flammability Limits in Air: Lower limit: not established. Upper limit: 100 %. This material may propagate a decomposition flame without air.

Autoignition Temperature: Not established.

Flammability Classification (per 29 CFR 1910.1200): Flammable gas.

Known or Anticipated Hazardous Products of Combustion: Germanium oxide.

Properties that may Initiate or Intensify Fire: Heating cylinder to the point of activation of the pressure relief device or to the point of initiating decomposition.

Reactions which Release Flammable Gases: Thermal decomposition releases hydrogen.

Extinguishing Media

None.

Fire Fighting Instructions

The only safe way to extinguish a flammable gas fire is to stop the flow of gas. If the flow cannot be stopped, allow the entire contents of the cylinder to burn. Cool the cylinder and surroundings with water from a suitable distance. Extinguishing the fire without stopping the flow of gas may permit the formation of ignitable or explosive mixtures with air. These mixtures may propagate to a source of ignition.

Excessive pressure may develop in gas cylinders exposed to fire, which may result in explosion, regardless of the cylinder's content. Cylinders with pressure relief devices (PRD's) may release their contents through such devices if the cylinder is exposed to fire. Cylinders without PRD's have no provision for controlled release and are therefore more likely to explode if exposed to fire.

Positive pressure, self contained breathing apparatus is required for all fire fighting involving hazardous materials. Full structural fire fighting (bunker) gear is the *minimum* acceptable attire. The need for proximity, entry, and flashover protection and special protective clothing should be determined for each incident by a competent fire fighting safety professional.

Section 6: Accidental Release Measures

Containment

This material is a gas at atmospheric conditions. The only means of containment is the enclosure of the space into which the material is released. Such containment is described in Section 7.

Clean Up

Clean up consists of passing the entire gas volume of the enclosure through appropriate exhaust gas treatment equipment (EGTE). Purge the enclosure with a non-reactive gas, such as nitrogen, through the EGTE until an acceptably low level of contamination remains. Equipment contaminated by this material must then be cleaned or decommissioned appropriately.

Evacuation

If the release is not contained in an appropriate device or system, all personnel not appropriately protected (see Section 8) must evacuate the contaminated spaces. Consider evacuation of additional areas, as a precaution against the spread of the release or subsequent explosion or fire.

Special Instructions

As leaks will not autoignite, consider the possible formation of ignitable or explosive mixtures with air.

Section 7: Handling and Storage

Handling

Handle this material only in sealed, purged systems. The design of handling systems for hazardous materials is beyond the scope of this MSDS, and should be performed by a competent, experienced professional. Consider the use of doubly-contained piping; diaphragm or bellows sealed, soft seat valves; backflow prevention devices; flash arrestors; and flow monitoring or limiting devices. Gas cabinets, with appropriate exhaust treatment, are recommended, as is automatic monitoring of the secondary enclosures and work areas for release.

Handle sealed gas cylinders in accordance with CGA P-1, *Safe Handling of Compressed Gases in Containers*.

Some material may have accumulated behind the outlet plug. Face the outlet away from you and wear appropriate protective equipment when removing the plug to connect the cylinder to your system.

Never introduce any substance into a gas cylinder. If you believe your cylinder may have been contaminated, notify Voltaix immediately. Provide as much information as possible on the nature and quantity of contamination.

Storage

Store cylinders in accordance with CGA P-1, *Safe Handling of Compressed Gases in Containers*, local building and fire codes and other relevant regulations. Materials should be segregated, by the hazards they comprise, for storage.

Protect the cylinders from direct sunlight, precipitation, mechanical damage, and temperatures above 55 ^{o}C (130 ^{o}F).

Ship and store cylinders with the outlet plug and valve protective cap in place.

Section 8: Exposure Control/Personal Protection

Engineering Controls

Local exhaust is required. Secondary containment, with appropriate exhaust gas treatment, is strongly encouraged and is required in some jurisdictions.

Monitor the work area and the secondary containment continuously for release of the material. Automatic alerting of personnel and automatic shutdown of flow are appropriate in most applications and are required in some jurisdictions.

Purge all primary containment systems with a nonreactive gas, such as nitrogen, before introducing germane.

Personal Protective Equipment (PPE)

Respiratory Protection: Positive pressure, full face, air supplied breathing apparatus should be used for work within the secondary containment equipment if a leak is suspected or the primary containment is to be opened, *e.g.*, for a cylinder change. Air supplied breathing apparatus is required for response to demonstrated or suspected releases from the primary containment.

Eye/Face Protection: When using respiratory protection as described above, use a face mask that provides splash and impact protection for the face and eyes. For handling sealed cylinders, wear safety glasses.

Skin Protection: Wear appropriate gloves when handling sealed cylinders. Use gloves and other skin protection, as assigned by a competent safety professional, when working within the secondary enclosure with the primary enclosure compromised, *e.g.*, cylinder changing. This is to protect both from exposure to the material and from fire that may result from its release to the air.

Other Protection: Wear appropriate protective footwear when moving cylinders.

Exposure Guidelines

TLV-TWA: 0.2 ppm (ACGIH).

PEL-TWA: 0.2 ppm (0.6 mg/m^3) (OSHA).

TWA (10 hour): 0.2 ppm (NIOSH).

Section 9: Physical and Chemical Properties

Property	Germane
Appearance	colorless
Odor	pungent
Physical state at atmospheric conditions	gas
pH	not applicable
Vapor Pressure	45 bar (640 psia) at 21 oC (70 ^oF)
Vapor Density	3.420 g/L at 0 ^oC (32 ^oF)
Boiling point (at 1 atm)	-88.4 ^oC (-127.0 ^oF)
Melting point	-165.9 ^oC (-266.6 ^oF)
Solubility in water (v/v)	insoluble
Specific gravity of liquid (water = 1)	1.523 at -142.0 ^oC (-223.6 ^oF)
Molecular weight	76.6662

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Section 10: Stability and Reactivity

Chemical Stability: Germane is stable at room temperature, but decomposes at elevated temperature to germanium and hydrogen.

Conditions to Avoid: Temperatures above 50 ^{o}C (122 ^{o}F), sources of ignition, exposure to air.

Incompatibility with Other Materials: Oxidizers, halogens.

Hazardous Decomposition, Reaction and Oxidation (other than burning) Products: Hydrogen, germanium oxide.

Hazardous Polymerization: Has not been observed.

Section 11: Toxicological Information

Acute Data (by route): Exposure by inhalation: LC_{50}, 1-hour, unspecified animal: 622 ppm. The primary effect is hemolysis.

Chronic and Subchronic Data: This material is listed in the Registry of Toxic Effects of Chemical Substances (RTECS), but no information on its carcinogenicity is available.

Special Studies: None known to Voltaix

Section 12: Ecological Information

Ecotoxicity: None known to Voltaix

Environmental Fate: None known to Voltaix

Section 13: Disposal Considerations

Classification under RCRA, 40 CFR 261: This material meets the criteria for an "acute hazardous waste".

US EPA waste number and descriptions: D001 (ignitability) and D003 (reactivity).

Special Instructions and Limitations: Treat process and other exhaust streams appropriately before release to the atmosphere.

Notice: The information above is derived from Voltaix's interpretation of the US federal laws, regulations and policies concerning the material, as shipped by Voltaix, at the time this MSDS was prepared. Federal controls are subject to change and state and local controls may also apply. Proper waste disposal is the responsibility of the owner of the waste. The user is encouraged to consult with appropriate experts in developing a disposal plan.

Section 14: Transport Information

Basic Description: Germane, Division 2.3 (Toxic Gas, Flammable Gas), UN 2192 Toxic - Inhalation Hazard, Inhalation Hazard Zone B.

Additional Information for shipment by water: IMDG Page Number 2143.

Additional Information for shipment by air: Transportation by air is not permitted.

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Section 15: Regulatory Information

TSCA Status: This material is listed in the index of chemical substances.

CERCLA Reportable Quantity (40CFR302.40): This material is not listed. The Reportable Quantity (RQ) for "Unlisted Hazardous Wastes Characteristic of Ignitability" (D001) or "Unlisted Hazardous Wastes Characteristic of Reactivity" (D003) of 45.4 kg (100 lbs.) therefore applies.

SARA Title III Status (Section 302 (40CFR355), Section 311/312, Section 313 (40CFR372)): No Threshold Planning Quantity (TPQ) or Reportable Quantity (RQ) is listed for this substance. The default federal MSDS submission and inventory requirement filing threshold of 4,540 kg (10,000 lbs.) therefore applies.
Note: State and local requirements may be more stringent.

Section 16: Other Information

References

Book of SEMI Standards, Facilities Standards and Safety Guidelines. Mountain View, CA: Semiconductor Equipment and Materials International, 1993.

Safe Handling of Compressed Gases in Containers (Pamphlet P-1). Arlington, VA: Compressed Gas Association, Inc., 1991.

Fire Protection Guide on Hazardous Materials. Quincy, MA: National Fire Protection Association, 1991.

Borak, Jonathan, M.D., Michael Callan and William Abbott, *Hazardous Materials Exposure: Emergency Response and Patient Care*. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1991.

Effects of Exposure to Toxic Gases: First Aid and Treatment. Lyndhurst, NJ: Matheson Gas Products, 1977.

Documentation of TLV's and BEI's. Cincinatti, Ohio: American Conference of Government Industrial Hygienists, 1992.

Revision Indication

Revise to reflect company name change

Disclaimer

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