1. IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND THE COMPANY/UNDERTAKING

Identification of the substance/preparation	:	Hydrogen Refrigerated
Chemical formula	:	H2
Other means of identification	:	Hydrogen (refrigerated), Cryogenic Liquid Hydrogen, Liquid Hydrogen
Use of the Substance/Mixture	:	General Industrial. Industrial and professional use.
Restrictions on Use	:	No data available.
Manufacturer/Importer/Distributor	:	Air Products Singapore Industrial Gases Pte. Ltd. 2 International Business Park The Strategy, #03-20 Singapore 609930 Toll Free No: 800 448 1755
Email Address – Technical Information	:	GASTECH@airproducts.com
Telephone	:	6332 2440
Emergency telephone number (24h)	:	+65 6853 6800 +1 610 481 7711 International

2. HAZARDS IDENTIFICATION

GHS classification

Flammable gases - Category 1A
Gases under pressure - Refrigerated liquefied gas.

GHS label elements

Hazard pictograms/symbols

Signal Word: Danger

Hazard Statements:

H220:Extremely flammable gas.
H281:Contains refrigerated gas; may cause cryogenic burns or injury.

Precautionary Statements:

Prevention	:	P210:Keep away from heat, hot surfaces, sparks, open flames, and other ignition sources. No smoking. P282:Wear cold insulating gloves/face shield/eye protection.
Response	:	P377 :Leaking gas fire: Do not extinguish, unless leak can be stopped safely. P381 :In case of leakage, eliminate all ignition sources. P336 :Thaw frosted parts with lukewarm water. Do not rub affected area. P315 :Get immediate medical advice/attention.
Storage	:	P403:Store in a well-ventilated place.

Other hazards which do not result in classification

Burns with an invisible flame.
Can ignite on contact with air.
Extremely cold liquid and gas under pressure.
Extremely flammable liquefied gas.
Vapors may spread long distances and ignite.
Direct contact with liquid can cause frostbite.
Avoid breathing gas.
Can cause rapid suffocation.
Self-contained breathing apparatus (SCBA) may be required.
High concentrations that can cause rapid suffocation are within the flammable range and should not be entered.
Immediate fire and explosion hazard exists when mixed with air at concentrations exceeding the lower flammability limit (LFL).

3. COMPOSITION/INFORMATION ON INGREDIENTS

Substance/Mixture : Substance

Components	Chemical formula	CAS Number	Concentration (Volume)
Hydrogen	H2	1333-74-0	100 %

Concentration is nominal. For the exact product composition, please refer to technical specifications.

4. FIRST AID MEASURES

General advice	:	Remove victim to uncontaminated area wearing self-contained breathing apparatus. Keep victim warm and rested. Call a doctor. Apply artificial respiration if breathing stopped.
Eye contact	:	In the case of contact with eyes, rinse immediately with plenty of water and seek medical advice. Keep eye wide open while rinsing. Seek medical advice.
Skin contact	:	In case of frostbite, obtain medical treatment immediately. Wash frost-bitten areas with plenty of water. Do not remove clothing. Cover wound with sterile dressing. Do not rub frozen parts as tissue damage may result. As soon as practical, place the affected area in a warm water bath - which has a temperature not to exceed 40 °C (105 °F).
Ingestion	:	Ingestion is not considered a potential route of exposure.

Inhalation	:	Move to fresh air. In case of shortness of breath, give oxygen. If breathing has stopped or is labored, give assisted respirations. Supplemental oxygen may be indicated. If the heart has stopped, trained personnel should begin cardiopulmonary resuscitation immediately.
Symptoms	:	Exposure to oxygen deficient atmosphere may cause the following symptoms: Dizziness. Salivation. Nausea. Vomiting. Loss of mobility/consciousness.
Notes to physician		
Treatment	:	If exposed or concerned: Get medical attention/advice.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media	:	Shutting off the source of the gas is the preferred method of control. Be aware of the risk of formation of static electricity with the use of CO2 extinguishers and do not use them in places where a flammable atmosphere may be present.
Extinguishing media which must not be used for safety reasons.	:	Do not use water jet to extinguish.
Specific hazards	:	Ignitable by static electricity. Burns with an invisible flame. Gas is lighter than air and can accumulate in the upper sections of enclosed spaces. Spill will rapidly vaporize and create an immediate flammable atmosphere. Move away from container and cool with water from a protected position. Keep containers and surroundings cool with water spray. Do not direct water spray at container vent. Do not extinguish a leaking gas flame unless absolutely necessary. Spontaneous/explosive re-ignition may occur. Extinguish any other fire. If possible, shut off the source of gas and allow the fire to burn itself out. Vapor cloud may obscure visibility.
Special protective equipment for fire-fighters	:	In confined space use self-contained breathing apparatus. Standard protective clothing and equipment (Self Contained Breathing Apparatus) for fire fighters. Standard EN 137 - Self-contained open-circuit compressed air breathing apparatus with full face mask. Standard EN 469 - Protective clothing for firefighters. Standard - EN 659: Protective gloves for firefighters.
Further information	:	The presence of a hydrogen flame can be detected by approaching cautiously with an outstretched straw broom to make the flame visible.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions	:	Evacuate personnel to safe areas. Approach suspected leak areas with caution. Remove all sources of ignition. Ventilate the area. Never enter a confined space or other area where the flammable gas concentration is greater the 10% of its lower flammable limit.
Environmental precautions	:	Prevent further leakage or spillage if safe to do so. Prevent from entering sewers, basements and workpits, or any place where its accumulation can be dangerous. Do not discharge into any place where its accumulation could be dangerous.
Methods for cleaning up	:	Ventilate the area. Do not spray water directly at leak.

Additional advice : If possible, stop flow of product. Increase ventilation to the release area and monitor concentrations. Do not direct water spray at container vent. Liquid spillages can cause embrittlement of struc tural materials. If leak is from cylinder or cylinder valve, call the emergency telephone number. If the leak is in the user's system, close the cylinder valve, safely vent the pressure, and purge with an inert gas before attempting repairs.

7. HANDLING AND STORAGE

Handling

May ignite if valve is opened to air. Know and understand the properties and hazards of the product before use. Before using the product, determine its identity by reading the label. Do not remove or deface labels provided by the supplier for the identification of the cylinder contents. Before connecting the container, check the complete gas system for suitability, particularly for pressure rating and materials. Before connecting the container for use, ensure that back feed from the system into the container is prevented. Close container valve after each use and when empty, even if still connected to equipment. Never attempt to repair or modify container valves or safety relief devices. Damaged valves should be reported immediately to the supplier. If user experiences any difficulty operating cylinder valve discontinue use and contact supplier. Do not remove or interchange connections. Only transfer lines designed for cryogenic liquids shall be used. Do not smoke while handling product or cylinders. Ensure the complete gas system has been checked for leaks before use. Prevent entrapment of cryogenic liquid in closed systems not protected with relief device. When moving cylinders, even for short distances, use a cart (trolley, hand truck, etc.) designed to transport cylinders. When doubt exists as to the correct handling procedure for a particular gas, contact the supplier. Employ suitable pressure regulating devices on all containers when the gas is being emitted to systems with lower pressure rating than that of the container. Do not subject containers to abnormal mechanical shock. Remove all sources of ignition. Ensure equipment is adequately earthed.

Storage

Do not allow storage temperature to exceed 50°C (122°F). Containers should be stored in a purpose build compound which should be well ventilated, preferably in the open air. Do not store in a confined space. Full containers should be stored so that oldest stock is used first. Full and empty cylinders should be segregated. Store containers in location free from fire risk and away from sources of heat and ignition. Return empty containers in a timely manner. Stored containers should be periodically checked for general condition and leakage. Protect containers stored in the open against rusting and extremes of weather. Containers should not be stored in conditions likely to encourage corrosion. All vents should be piped to the exterior of the building. Cryogenic containers are equipped with pressure relief devices to control internal pressure. Under normal conditions these containers will periodically vent product. Display "No Smoking or Open Flames" signs in the storage areas. Flammable storage areas should be separated from oxygen and other oxidizers by a minimum distance of 20 ft. (6.1 m.) or by a barrier of non-combustible material at least 5 ft. (1.5 m.) high, having a fire resistance rating of at least 1/2 hour. All electrical equipment should be explosion-proo f in the storage areas. Smoking should be prohibited within storage areas or while handling product or containers. Observe all regulations and local requirements regarding storage of containers.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering measures

Provide natural or explosion-proof ventilation that is adequate to ensure flammable gas does not reach its lower explosive limit.
Use explosion-proof equipment.
Keep self-contained breathing apparatus readily available for emergency use.

Personal protective equipment

Respiratory protection	:	High concentrations that can cause rapid suffocation are within the flammable range and should not be entered. Self contained breathing apparatus (SCBA) or positive pressure airline with mask are to be used in oxygen-deficient atmospheres. Users of breathing apparatus must be trained.
Hand protection	:	Wear work gloves when handling gas containers. Standard EN 388 - Protective gloves against mechanical risk. If the operation involves possible exposure to a cryogenic liquid, wear loose fitting thermal insulated or cryo-gloves. Standard EN 511 - Cold insulating gloves.
Eye protection	:	Safety glasses recommended when handling cylinders. Wear goggles and a face shield when transfilling or breaking transfer connections. Standard EN 166 - Personal eye-protection.
Skin and body protection	:	Never allow any unprotected part of the body to touch uninsulated pipes or vessels which contain cryogenic fluids. The extremely cold metal will cause the flesh to stick fast and tear when one attempts to withdraw from it. Safety shoes are recommended when handling cylinders. Standard EN ISO 20345 - Personal protective equipment - Safety footwear. Consider the use of flame resistant anti-static safety clothing. Standard EN ISO 14116 - Limited flame spread materials. Standard EN ISO 1149-5 - Protective clothing: Electrostatic properties.
Special instructions for protection and hygiene	:	Ensure adequate ventilation, especially in confined areas.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	:	Liquefied gas. Colorless.
Odor	:	Odorless.
Odor threshold	:	No data available.
pH	:	Not applicable.
Melting point/range	:	-435 °F (-259.2 °C)
Boiling point/range	:	-423 °F (-253 °C)
Flash point	:	Not applicable.
Evaporation rate	:	Not applicable.
Flammability (solid, gas)	:	Refer to product classification in Section 2
Upper/lower explosion/flammability limit	:	77 %(V) / 4 %(V)
Vapor pressure	:	Not applicable.

Water solubility	:	0.0016 g/l
Relative vapor density	:	0.07 (air = 1) Lighter or similar to air.
Relative density	:	0.07 (water = 1)
Partition coefficient: n-octanol/water [log Kow]	:	Not applicable.
Auto-ignition temperature	:	560 °C
Decomposition temperature	:	No data available.
Viscosity	:	Not applicable.
Molecular Weight	:	2 g/mol

10. STABILITY AND REACTIVITY

Chemical Stability	:	Stable under normal conditions.
Conditions to avoid	:	Heat, flames and sparks.
Reactivity/Incompatible Materials	:	Oxygen. Oxidizing agents. Materials such as carbon steel, low alloy carbon steel and plastic become brittle at low temperatures and are subject to failure. Use appropriate materials compatible with the cryogenic conditions present in refrigerated liquefied gas systems.
Hazardous decomposition products	:	Under normal conditions of storage and use, hazardous decomposition products should not be produced.

11. TOXICOLOGICAL INFORMATION

Likely routes of exposure

Effects on Eye	:	Contact with liquid may cause cold burns/frostbite.
Effects on Skin	:	Contact with liquid may cause cold burns/frostbite. May cause severe frostbite.
Inhalation Effects	:	In high concentrations may cause asphyxiation. Symptoms may include loss of mobility/consciousness. Victim may not be aware of asphyxiation. Asphyxiation may bring about unconsciousness without warning and so rapidly that victim may be unable to protect themselves.
Ingestion Effects	:	Ingestion is not considered a potential route of exposure.
Symptoms	:	Exposure to oxygen deficient atmosphere may cause the following symptoms: Dizziness. Salivation. Nausea. Vomiting. Loss of

mobility/consciousness.

Acute toxicity

Acute Oral Toxicity	:	No data is available on the product itself.
Inhalation	:	No data is available on the product itself.
Acute Dermal Toxicity	:	No data is available on the product itself.
Serious eye damage/eye irritation	:	No data available.
Sensitization.	:	No data available.

Chronic toxicity or effects from long term exposures

Carcinogenicity	:	No data available.
Reproductive toxicity	:	No data is available on the product itself.
Germ cell mutagenicity	:	No data is available on the product itself.
Specific target organ systemic toxicity (single exposure)	:	No data available.
Specific target organ systemic toxicity (repeated exposure)	:	No data available.
Aspiration hazard	:	No data available.

12. ECOLOGICAL INFORMATION

Ecotoxicity effects

Aquatic toxicity	:	Not applicable.
Toxicity to other organisms	:	Not applicable.

Persistence and degradability

Biodegradability	:	No data is available on the product itself.
Mobility	:	Because of its high volatility, the product is unlikely to cause ground pollution.
Bioaccumulation	:	Refer to Section 9 "Partition Coefficient (n-octanol/water)".

Further information

When discharged in large quantities may contribute to the greenhouse effect.

13. DISPOSAL CONSIDERATIONS

Waste from residues / unused products	:	Return unused product in original cylinder to supplier. Contact supplier if guidance is required. Do not discharge into areas where there is a risk of forming an explosive mixture with air. Waste gas should be flared through a suitable burner with flash back arrestor. Refer to the EIGA code of practice Doc. 30 "Disposal of Gases", downloadable at http://www.eiga.org for more guidance on suitable disposal methods. List of hazardous waste codes: 16 05 04*: gases in pressure containers (including halons) containing hazardous substances.
Contaminated packaging	:	Return cylinder to supplier.

14. TRANSPORT INFORMATION

ADR

UN/ID No.	:	UN1966
Proper shipping name	:	HYDROGEN, REFRIGERATED LIQUID
Class or Division	:	2
Tunnel Code	:	(B/D)
Label(s)	:	2.1
ADR/RID Hazard ID no.	:	223
Marine Pollutant	:	No

IATA

Transport forbidden

IMDG

UN/ID No.	:	UN1966
Proper shipping name	:	HYDROGEN, REFRIGERATED LIQUID
Class or Division	:	2.1
Label(s)	:	2.1
Marine Pollutant	:	No
Segregation Group	:	None

RID

UN/ID No.	:	UN1966
Proper shipping name	:	HYDROGEN, REFRIGERATED LIQUID
Class or Division	:	2
Label(s)	:	2.1
Marine Pollutant	:	No

Further Information

Avoid transport on vehicles where the load space is not separated from the driver's compartment. Ensure vehicle driver is aware of the potential hazards of the load and knows what to do in the event of an accident or an emergency. The transportation information is not intended to convey all specific regulatory data relating to this material. For complete transportation information, contact customer service.

15. REGULATORY INFORMATION

Workplace Safety and Health Act & Workplace Safety and Health (General Provisions) Regulations

Workplace Health and Safety Act , SS586 Labeling.

Flammable Materials Regulation Licensable Chemicals (Singapore Civil Defense Force).

Country	Regulatory list	Notification
USA	TSCA	Included on Inventory.
EU	EINECS	Included on Inventory.
Canada	DSL	Included on Inventory.
Australia	AICS	Included on Inventory.
South Korea	ECL	Included on Inventory.
China	SEPA	Included on Inventory.
Philippines	PICCS	Included on Inventory.
Japan	ENCS	Included on Inventory.

16. OTHER INFORMATION

Ensure all national/local regulations are observed.

Prepared by : Air Products and Chemicals, Inc. Global EH&S Department

For additional information, please visit our web site at http://www.airproducts.com.