



HYDROGEN, REFRIGERATED LIQUID

Safety Data Sheet

1. IDENTIFICATION

Product identifier

Product Name HYDROGEN, REFRIGERATED LIQUID

Other means of identification

Safety data sheet number LIND-P067
 UN/ID no. UN1966
 Synonyms LH2; Para Hydrogen

Recommended use of the chemical and restrictions on use

Recommended Use Industrial and professional use.
 Uses advised against Consumer use

Details of the supplier of the safety data sheet

Linde Gas North America LLC - Linde Merchant Production Inc. - Linde LLC
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 Murray Hill, NJ 07974
 Phone: 908-464-8100
www.lindeus.com

Linde Gas Puerto Rico, Inc.
 Road 869, Km 1.8
 Barrio Palmas, Catano, PR 00962
 Phone: 787-641-7445
www.pr.lindegas.com

Linde Canada Limited
 5860 Chedworth Way
 Mississauga, Ontario L5R 0A2
 Phone: 905-501-1700
www.lindecana.com

* May include subsidiaries or affiliate companies/divisions.

For additional product information contact your local customer service.

Emergency telephone number

Company Phone Number 800-232-4726 (Linde National Operations Center, US)
 905-501-0802 (Canada)

CHEMTREC: 1-800-424-9300 (North America) +1-703-527-3887 (International)

2. HAZARDS IDENTIFICATION

Classification

OSHA Regulatory Status

This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200).

| | |
|----------------------|----------------------------|
| Flammable gases | Category 1 |
| Gases under pressure | Refrigerated liquefied gas |
| Simple asphyxiants | Yes |

Label elements



Hazard Statements

Extremely flammable gas
 Contains refrigerated gas; may cause cryogenic burns or injury
 May displace oxygen and cause rapid suffocation
 May form explosive mixtures with air
 Burns with invisible flame

Precautionary Statements - Prevention

Do not handle until all safety precautions have been read and understood
 Keep away from heat/sparks/open flames/hot surfaces. — No smoking
 Use and store only outdoors or in a well ventilated place
 Wear cold insulating gloves/face shield/eye protection
 Use backflow preventive device in piping
 Do NOT change or force fit connections
 Close valve after each use and when empty
 Use insulated hoses and piping to avoid condensation of oxygen-rich liquid air
 Always keep container in upright position

Precautionary Statements - Response

IF INHALED: Remove person to fresh air and keep comfortable for breathing. Get medical attention/advice.
 IF ON SKIN: Thaw frosted parts with lukewarm water. Do not rub affected area. Get immediate medical advice/attention.
 Leaking gas fire: do not extinguish, unless leak can be stopped safely
 Eliminate all ignition sources if safe to do so

Hazards not otherwise classified (HNOC)

Not applicable

3. COMPOSITION/INFORMATION ON INGREDIENTS

| Chemical Name | CAS No. | Volume % | Chemical Formula |
|---------------|-----------|----------|------------------|
| Hydrogen | 1333-74-0 | 100 | H ₂ |

4. FIRST AID MEASURES

Description of first aid measures

| | |
|------------------------------------|--|
| General advice | Show this safety data sheet to the doctor in attendance. |
| Inhalation | Remove to fresh air and keep comfortable for breathing. If breathing is difficult, give oxygen. If breathing has stopped, give artificial respiration. Get medical attention immediately. |
| Skin contact | For dermal contact or suspected frostbite, remove contaminated clothing and flush affected areas with lukewarm water. DO NOT USE HOT WATER. A physician should see the patient promptly if contact with the product has resulted in blistering of the dermal surface or in deep tissue freezing. |
| Eye contact | If frostbite is suspected, flush eyes with cool water for 15 minutes and obtain immediate medical attention. |
| Ingestion | Not an expected route of exposure. |
| Self-protection of the first aider | RESCUE PERSONNEL SHOULD BE EQUIPPED WITH SELF-CONTAINED BREATHING APPARATUS. Remove all sources of ignition. |

Most important symptoms and effects, both acute and delayed

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| Symptoms | Simple asphyxiant. May cause suffocation by displacing the oxygen in the air. Exposure to oxygen-deficient atmosphere (<19.5%) may cause dizziness, drowsiness, nausea, vomiting, excess salivation, diminished mental alertness, loss of consciousness and death. Exposure to atmospheres containing 8-10% or less oxygen will bring about unconsciousness without warning and so quickly that the individuals cannot help or protect themselves. Lack of sufficient oxygen may cause serious injury or death. Contact with liquid may cause cold burns/frostbite. |
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Indication of any immediate medical attention and special treatment needed

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| Note to physicians | Treat symptomatically. |
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5. FIRE-FIGHTING MEASURES

Suitable extinguishing media

Dry chemical or CO₂. Water spray (fog). DO NOT EXTINGUISH A LEAKING GAS FIRE UNLESS LEAK CAN BE STOPPED.

Specific extinguishing methods

If possible, stop the flow of gas. Do not extinguish the fire until supply is shut off as otherwise an explosive-ignition may occur. If the fire is extinguished and the flow of gas continues, use increased ventilation to prevent build-up of explosive atmosphere. Ventilation fans must be explosion proof. Use non-sparking tools to close container valves.

Use water spray to cool surrounding containers. Be cautious of a Boiling Liquid Evaporating Vapor Explosion, BLEVE, if flame is impinging on surrounding containers. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible withdraw from area and let fire burn. Damaged cylinders should be handled only by specialists.

Specific hazards arising from the chemical

Extremely flammable gas. May form explosive mixtures with air. Hydrogen is very light and may collect in the upper portions of storage areas. Hydrogen burns with an almost invisible flame. High pressure releases may ignite with no apparent ignition source possibly via static electricity. Vapors may travel to source of ignition and flash back. Vapors may accumulate in confined areas (basement, tanks, hopper/tank cars, etc.). Cylinders may rupture under extreme heat.

Protective equipment and precautions for firefighters

As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear. As an immediate precautionary measure, isolate spill or leak area for at least 100 meters (330 feet) in all directions.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

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| Personal precautions | ELIMINATE all ignition sources (no smoking, flares, sparks or flames in immediate area). Evacuate personnel to safe areas. Ensure adequate ventilation, especially in confined areas. Monitor oxygen level. Consider the risk of potentially explosive atmospheres. All equipment used when handling the product must be grounded. Use non-sparking tools and equipment. Wear self-contained breathing apparatus when entering area unless atmosphere is proved to be safe. |
| Other Information | When in contact with refrigerated/cryogenic liquids, many materials become brittle and are likely to break without warning. |

Environmental precautions

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| Environmental precautions | Prevent spreading of vapors through sewers, ventilation systems and confined areas. |
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Methods and material for containment and cleaning up

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| Methods for containment | Stop the flow of gas or remove cylinder to outdoor location if this can be done without risk. If leak is in container or container valve, contact the appropriate emergency telephone number in Section 1 or call your closest Linde location. |
| Methods for cleaning up | Return Portable Cryogenic Container to Linde or an authorized distributor. |

7. HANDLING AND STORAGE

Precautions for safe handling

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| Advice on safe handling | <p>Liquid hydrogen is delivered into stationary vacuum jacketed vessels at the customers' location. Consult manufacturer's instructions. NEVER HANDLE LIQUID HYDROGEN IN OPEN VESSELS. NEVER ALLOW LIQUID HYDROGEN TO BOIL IN A SEALED CONTAINER. The excessive pressure could result in vessel rupture. Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking. Ground and bond all lines and equipment associated with product system. All equipment should be non-sparking and explosion proof. Separate flammable gas cylinders from oxygen and other oxidizers by a minimum distance of 20 ft. or by a 5 ft. high barrier with a minimum fire resistance rating of a half an hour. NO SMOKING" signs should be posted in storage and use areas. Never allow any unprotected part of the body to touch uninsulated pipes or vessels that contain cold fluids. The extremely cold metal will cause moist flesh to stick fast and tear when one attempts to withdraw from it. Do NOT change or force fit connections.</p> <p>Liquid hydrogen in uninsulated piping may condense oxygen out of the atmosphere. Do not allow the liquified air to contact oils, greases, or other combustible materials such as asphalt and motor oil. See container manufacturer's operating instructions to avoid freezing air in vent lines. Hydrogen is non-corrosive. However hydrogen can interact with metals (hardened steels) to cause embrittlement.</p> |
|-------------------------|---|

Protect cylinders from physical damage; do not drag, roll, slide or drop. When moving cylinders, even for short distance, use a cart designed to transport cylinders. Never attempt to lift a cylinder by its valve protection cap. Never insert an object (e.g. wrench, screwdriver, pry bar, etc.) into valve cap openings. Doing so may damage valve, causing leak to occur. Use an adjustable strap wrench to remove over-tight or rusted caps. Use only with adequate ventilation. Use backflow preventive device in piping. Use only with equipment rated for cylinder pressure. Close valve after each use and when empty. If user experiences any difficulty operating cylinder valve discontinue use and contact supplier. Ensure the complete gas system has been checked for leaks before use.

Never put cylinders into trunks of cars or unventilated areas of passenger vehicles. Never attempt to refill a compressed gas cylinder without the owner's written consent. Never strike an arc on a compressed gas cylinder or make a cylinder a part of an electrical circuit.

Only experienced and properly instructed persons should handle gases under pressure. Always store and handle compressed gas cylinders in accordance with Compressed Gas Association, pamphlet CGA-P1, Safe Handling of Compressed Gases in Containers.

For additional storage recommendations, consult Compressed Gas Association's pamphlets G-5, G-5.3, G-5.5, P-1, P-6, P-12, SB-2 and OSHA 1910 Subpart H. NFPA 50B covers liquefied hydrogen at consumer sites.

Conditions for safe storage, including any incompatibilities

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| Storage Conditions | Store in cool, dry, well-ventilated area of non-combustible construction away from heavily trafficked areas and emergency exits. Keep at temperatures below 52°C / 125°F. Cylinders should be stored upright with valve protection cap in place and firmly secured to prevent falling. Use a "first in-first out" inventory system to prevent full cylinders from being stored for excessive periods of time. Full and empty cylinders should be segregated. Stored containers should be periodically checked for general condition and leakage. Outside or detached storage is preferred. |
| Incompatible materials | Oxidizing agents. |

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control parameters

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| Exposure Guidelines | This product does not contain any hazardous materials with occupational exposure limits established by the region specific regulatory bodies. |
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Appropriate engineering controls

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| Engineering Controls | Explosion proof ventilation systems. Local exhaust ventilation to prevent accumulation of high concentrations and maintain air-oxygen levels at or above 19.5%. Oxygen detectors should be used when asphyxiating gases may be released. Consider installation of leak detection systems in areas of use and storage. Showers. Eyewash stations. |
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Individual protection measures, such as personal protective equipment

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|--------------------------------|---|
| Eye/face protection | Wear safety glasses with side shields (or goggles). If splashes are likely to occur, wear: Goggles. Face-shield. |
| Skin and body protection | Work gloves and safety shoes are recommended when handling cylinders. Wear cold insulating gloves when handling liquid. Wear fire/flame resistant/retardant clothing. Take precautionary measures against static discharge. |
| Respiratory protection | Use positive pressure airline respirator with escape cylinder or self contained breathing apparatus for oxygen-deficient atmospheres (<19.5%). |
| General Hygiene Considerations | Handle in accordance with good industrial hygiene and safety practice. Do not get in eyes, on skin, or on clothing. |

Skin and body protection

Antistatic footwear Wear fire/flame resistant/retardant clothing Gloves made of plastic or rubber

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

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|---------------------------|--------------------------|
| Physical state | Cryogenic Liquid |
| Appearance | Colorless. |
| Odor | Odorless. |
| Odor threshold | No information available |
| pH | No data available |
| Melting point | -259.2 °C / -434.8 °F |
| Evaporation rate | Not applicable |
| Fire Hazard | Yes |
| Flammability Limit in Air | |
| Lower flammability limit: | 4% |
| Upper flammability limit: | 75% |
| Flash point | No information available |
| Autoignition temperature | 570 °C / 1058 °F |
| Decomposition temperature | No data available |
| Water solubility | 0.019 vol/vol @ 15.6°C |
| Partition coefficient | No data available |
| Kinematic viscosity | Not applicable |

| Chemical Name | Molecular weight | Boiling point | Vapor Pressure | Vapor density (air =1) | Gas Density Kg/m ³ @20°C | Critical Temperature |
|---------------|------------------|---------------|----------------------------|------------------------|-------------------------------------|----------------------|
| Hydrogen | 1.00 | -252.8 °C | Above critical temperature | 0.07 | 0.083 | -240 °C |

10. STABILITY AND REACTIVITY

Reactivity

Not reactive under normal conditions.

Chemical stability

Stable under normal conditions.

Explosion data

| | |
|----------------------------------|-------|
| Sensitivity to Mechanical Impact | None. |
| Sensitivity to Static Discharge | Yes. |

Possibility of Hazardous Reactions

May form explosive mixtures with air. May react violently with oxidizers.

Conditions to avoid

Heat, flames and sparks.

Incompatible materials

Oxidizing agents.

Hazardous Decomposition Products

None known.

11. TOXICOLOGICAL INFORMATION

Information on likely routes of exposure

Inhalation

Product is a simple asphyxiant.

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|--------------|---|
| Skin contact | Contact with liquid may cause cold burns/frostbite. |
| Eye contact | Contact with liquid may cause cold burns/frostbite. |
| Ingestion | Not an expected route of exposure. |

Information on toxicological effects

| | |
|----------|---------------------------|
| Symptoms | No information available. |
|----------|---------------------------|

Delayed and immediate effects as well as chronic effects from short and long-term exposure

| | |
|--------------------------|---|
| Irritation | Not classified. |
| Sensitization | Not classified. |
| Germ cell mutagenicity | Not classified. |
| Carcinogenicity | This product does not contain any carcinogens or potential carcinogens listed by OSHA, IARC or NTP. |
| Reproductive toxicity | Not classified. |
| STOT - single exposure | Not classified. |
| STOT - repeated exposure | Not classified. |
| Chronic toxicity | None known. |
| Aspiration hazard | Not applicable. |

Numerical measures of toxicity

| Chemical Name | Oral LD50 | Dermal LD50 | Inhalation LC50 | Inhalation LC50 (CGA P-20) |
|-----------------------|-----------|-------------|-----------------------|-------------------------------|
| Hydrogen 1333-74-0 | - | - | > 15000 ppm (Rat) 1 h | - |

Product Information

| | |
|-----------------|---------------------------|
| Oral LD50 | No information available |
| Dermal LD50 | No information available. |
| Inhalation LC50 | No information available |

12. ECOLOGICAL INFORMATIONEcotoxicity

No known acute aquatic toxicity.

Persistence and degradability

Not applicable.

Bioaccumulation

No information available.

Other adverse effects

Can cause frost damage to vegetation.

13. DISPOSAL CONSIDERATIONSWaste treatment methods

| | |
|--------------------|---|
| Disposal of wastes | Do not attempt to dispose of residual waste or unused quantities. Return in the shipping container PROPERLY LABELED WITH ANY VALVE OUTLET PLUGS OR CAPS SECURED AND VALVE PROTECTION CAP IN PLACE to Linde for proper disposal. |
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14. TRANSPORT INFORMATION

DOT

| | |
|---------------------------------|--|
| UN/ID no. | UN1966 |
| Proper shipping name | Hydrogen, refrigerated liquid |
| Hazard Class | 2.1 |
| Special Provisions | T75, TP5 |
| Description | UN1966, Hydrogen, refrigerated liquid, 2.1 |
| Emergency Response Guide Number | 115 |

TDG

| | |
|----------------------|--|
| UN/ID no. | UN1966 |
| Proper shipping name | Hydrogen, refrigerated liquid |
| Hazard Class | 2.1 |
| Description | UN1966, Hydrogen, refrigerated liquid, 2.1 |

MEX

| | |
|----------------------|--|
| UN/ID no. | UN1966 |
| Proper shipping name | Hydrogen, refrigerated liquid |
| Hazard Class | 2.1 |
| Description | UN1966, Hydrogen, refrigerated liquid, 2.1 |

IATA

Forbidden

IMDG

| | |
|----------------------|--|
| UN/ID no. | UN1966 |
| Proper shipping name | Hydrogen, refrigerated liquid |
| Hazard Class | 2.1 |
| EmS-No. | F-D, S-U |
| Description | UN1966, Hydrogen, refrigerated liquid, 2.1 |

ADR

| | |
|-------------------------|---|
| UN/ID no. | UN1966 |
| Proper shipping name | Hydrogen, refrigerated liquid |
| Hazard Class | 2.1 |
| Classification code | 3F |
| Tunnel restriction code | (B/D) |
| Description | UN1966, Hydrogen, refrigerated liquid, 2.1, (B/D) |

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| 15. REGULATORY INFORMATION |
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International Inventories

| | |
|---------------|----------|
| TSCA | Complies |
| DSL | Complies |
| EINECS/ELINCS | Complies |

Legend:

TSCA - United States Toxic Substances Control Act Section 8(b) Inventory

DSL/NDL - Canadian Domestic Substances List/Non-Domestic Substances List

EINECS/ELINCS - European Inventory of Existing Chemical Substances/European List of Notified Chemical Substances

US Federal RegulationsSARA 313

Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product does not contain any chemicals which are subject to the reporting requirements of the Act and Title 40 of the Code of Federal Regulations, Part 372.

SARA 311/312 Hazard Categories

| | |
|-----------------------------------|-----|
| Acute Health Hazard | Yes |
| Chronic Health Hazard | No |
| Fire Hazard | Yes |
| Sudden release of pressure hazard | Yes |
| Reactive Hazard | No |

CERCLA

This material, as supplied, does not contain any substances regulated as hazardous substances under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302) or the Superfund Amendments and Reauthorization Act (SARA) (40 CFR 355). There may be specific reporting requirements at the local, regional, or state level pertaining to releases of this material.

Clean Air Act, Section 112 Hazardous Air Pollutants (HAPS) (see 40 CFR 61)

This product does not contain any substances regulated as hazardous air pollutants (HAPS) under Section 112 of the Clean Air Act Amendments of 1990.

CWA (Clean Water Act)

This product does not contain any substances regulated as pollutants pursuant to the Clean Water Act (40 CFR 122.21 and 40 CFR 122.42)

Risk and Process Safety Management Programs

This material, as supplied, contains one or more regulated substances with specified thresholds under 40 CFR Part 68 or regulated as a highly hazardous chemical pursuant to the 29 CFR Part 1910.110 with specified thresholds:

| Chemical Name | U.S. - CAA (Clean Air Act) - Accidental Release Prevention - Toxic Substances | U.S. - CAA (Clean Air Act) - Accidental Release Prevention - Flammable Substances | U.S. - OSHA - Process Safety Management - Highly Hazardous Chemicals |
|---------------|---|---|--|
| Hydrogen | | 10000 lbs | |

US State RegulationsCalifornia Proposition 65

This product does not contain any Proposition 65 chemicals

U.S. State Right-to-Know Regulations

| Chemical Name | New Jersey | Massachusetts | Pennsylvania |
|-----------------------|------------|---------------|--------------|
| Hydrogen 1333-74-0 | X | X | X |

International Regulations

16. OTHER INFORMATION

NFPA Health hazards 3 Flammability 4 Instability 0 Physical and Chemical Properties -

Note: Ratings were assigned in accordance with Compressed Gas Association (CGA) guidelines as published in CGA Pamphlet P-19-2009, CGA Recommended Hazard Ratings for Compressed Gases, 3rd Edition.

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Revision Date 24-Feb-2015
Revision Note Initial Release.

General Disclaimer

For terms and conditions, including limitation of liability, please refer to the purchase agreement in effect between Linde LLC, Linde Merchant Production, Inc. or Linde Gas North America LLC (or any of their affiliates and subsidiaries) and the purchaser.

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End of Safety Data Sheet