SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product identifier
Trade name: Hydrogen (refrigerated)
SDS no: 067B
Chemical description: Hydrogen, refrigerated
CAS-No.: 1333-74-0
EC-No.: 215-605-7
EC Index-No.: 001-001-00-9
Registration-No.: Listed in Annex IV / V REACH, exempted from registration.
Chemical formula: H2

1.2. Relevant identified uses of the substance or mixture and uses advised against
Uses advised against: Consumer use.

1.3. Details of the supplier of the safety data sheet
Company identification
Supplier:
AIR LIQUIDE Deutschland GmbH
Luise-Rainer-Straße 5
40235 Düsseldorf - GERMANY
T +49 (0)211 6699-0 - F +49 (0)211 6699-222
info@airliquide.de
E-Mail address (competent person): info.SDB@airliquide.de

1.4. Emergency telephone number
Emergency telephone number: +49 (0)2151 398668
Availability: ( 24 / 7 )

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture
Classification according to Regulation (EC) No. 1272/2008 [CLP]
Physical hazards: Flammable gases, Category 1 - H220
Gases under pressure: Refrigerated liquefied gas - H281

2.2. Label elements
Labelling according to Regulation (EC) No. 1272/2008 [CLP]
Hazard pictograms (CLP):

Signal word (CLP): Danger
Hazard statements (CLP):
H220 - Extremely flammable gas.
H281 - Contains refrigerated gas; may cause cryogenic burns or injury.
Precautionary statements (CLP):
- Prevention: P282 - Wear cold insulating gloves and either face shield or eye protection.
P210 - Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No
Hydrogen (refrigerated)

2.3. Other hazards

: None.

SECTION 3: Composition/information on ingredients

3.1. Substances

<table>
<thead>
<tr>
<th>Name</th>
<th>Product identifier</th>
<th>Composition [V-%]: 100</th>
<th>Classification according to Regulation (EC) No. 1272/2008 [CLP]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen, refrigerated</td>
<td>(CAS-No.) 1333-74-0</td>
<td></td>
<td>Flam. Gas 1, H220</td>
</tr>
<tr>
<td></td>
<td>(EC-No.) 215-605-7</td>
<td></td>
<td>Press. Gas (Ref. Liq.), H281</td>
</tr>
<tr>
<td></td>
<td>(EC Index-No.) 001-001-00-9</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Registration-No.) *1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Contains no other components or impurities which will influence the classification of the product.

*1: Listed in Annex IV / V REACH, exempted from registration.

*2: Registration deadline not expired.

*3: Registration not required: Substance manufactured or imported < 1t/y.

3.2. Mixtures : Not applicable.

SECTION 4: First aid measures

4.1. Description of first aid measures

- Inhalation : Remove victim to uncontaminated area wearing self contained breathing apparatus. Keep victim warm and rested. Call a doctor. Apply artificial respiration if breathing stopped.

- Skin contact : In case of frostbite spray with water for at least 15 minutes. Apply a sterile dressing. Obtain medical assistance.

- Eye contact : Immediately flush eyes thoroughly with water for at least 15 minutes.

- Ingestion : Ingestion is not considered a potential route of exposure.

4.2. Most important symptoms and effects, both acute and delayed

: Refer to section 11.

4.3. Indication of any immediate medical attention and special treatment needed

: None.

SECTION 5: Firefighting measures

5.1. Extinguishing media

- Suitable extinguishing media : Water spray or fog.

- Unsuitable extinguishing media : Carbon dioxide.

- Dry powder.

Do not use water jet to extinguish.

5.2. Special hazards arising from the substance or mixture

Specific hazards : Exposure to fire may cause containers to rupture/explode.

Hazardous combustion products : None.
5.3. Advice for firefighters
Specific methods:
Use fire control measures appropriate for the surrounding fire. Exposure to fire and heat radiation may cause gas receptacles to rupture. Cool endangered receptacles with water spray jet from a protected position. Prevent water used in emergency cases from entering sewers and drainage systems.
If possible, stop flow of product.
Use water spray or fog to knock down fire fumes if possible.
If leaking do not spray water onto container. Water surrounding area (from protected position) to contain fire.
Do not extinguish a leaking gas flame unless absolutely necessary. Spontaneous/explosive re-ignition may occur. Extinguish any other fire.
Move containers away from the fire area if this can be done without risk.

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.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures:
Try to stop release.
Evacuate area.
Monitor concentration of released product.
Consider the risk of potentially explosive atmospheres.
Wear self-contained breathing apparatus when entering area unless atmosphere is proved to be safe.
Eliminate ignition sources.
Use protective clothing.
Ensure adequate air ventilation.
Act in accordance with local emergency plan.
Stay upwind.

6.2. Environmental precautions:
Try to stop release.
Liquid spillages can cause embrittlement of structural materials.

6.3. Methods and material for containment and cleaning up:
Ventilate area.

6.4. Reference to other sections:
See also sections 8 and 13.

SECTION 7: Handling and storage

7.1. Precautions for safe handling:
Safe use of the product:
The product must be handled in accordance with good industrial hygiene and safety procedures.
Only experienced and properly instructed persons should handle gases under pressure.
Consider pressure relief device(s) in gas installations.
Ensure the complete gas system was (or is regularly) checked for leaks before use.
Do not smoke while handling product.
Use only properly specified equipment which is suitable for this product, its supply pressure and temperature. Contact your gas supplier if in doubt.
Avoid suck back of water, acid and alkalis.
Assess the risk of potentially explosive atmospheres and the need for explosion-proof
Hydrogen (refrigerated)

Purge air from system before introducing gas.
Take precautionary measures against static discharge.
Keep away from ignition sources (including static discharges).
Consider the use of only non-sparking tools.
Do not breathe gas.
Avoid release of product into atmosphere.
Ensure equipment is adequately earthed.

Safe handling of the gas receptacle:
- Refer to supplier's container handling instructions.
- Do not allow backfeed into the container.
- Protect cylinders from physical damage; do not drag, roll, slide or drop.
- When moving cylinders, even for short distances, use a cart (trolley, hand truck, etc.) designed to transport cylinders.
- Leave valve protection caps in place until the container has been secured against either a wall or bench or placed in a container stand and is ready for use.
- If user experiences any difficulty operating cylinder valve discontinue use and contact supplier.
- Never attempt to repair or modify container valves or safety relief devices.
- Damaged valves should be reported immediately to the supplier.
- Keep container valve outlets clean and free from contaminants particularly oil and water.
- Replace valve outlet caps or plugs and container caps where supplied as soon as container is disconnected from equipment.
- Close container valve after each use and when empty, even if still connected to equipment.
- Never attempt to transfer gases from one cylinder/container to another.
- Never use direct flame or electrical heating devices to raise the pressure of a container.
- Do not remove or deface labels provided by the supplier for the identification of the cylinder contents.
- Suck back of water into the container must be prevented.
- Open valve slowly to avoid pressure shock.

7.2. Conditions for safe storage, including any incompatibilities:
- Observe all regulations and local requirements regarding storage of containers.
- Containers should not be stored in conditions likely to encourage corrosion.
- Container valve guards or caps should be in place.
- Containers should be stored in the vertical position and properly secured to prevent them from falling over.
- Stored containers should be periodically checked for general condition and leakage.
- Keep container below 50°C in a well ventilated place.
- Store containers in location free from fire risk and away from sources of heat and ignition.
- Keep away from combustible materials.
- Segregate from oxidant gases and other oxidants in store.
- All electrical equipment in the storage areas should be compatible with the risk of a potentially explosive atmosphere.

7.3. Specific end use(s):
- None.

SECTION 8: Exposure controls/personal protection

8.1. Control parameters:
- OEL (Occupational Exposure Limits): No data available.
- DNEL (Derived-No Effect Level): No data available.
- PNEC (Predicted No-Effect Concentration): No data available.
8.2 Exposure controls

8.2.1. Appropriate engineering controls

- Provide adequate general and local exhaust ventilation.
- Product to be handled in a closed system.
- Systems under pressure should be regularly checked for leakages.
- Gas detectors should be used when flammable gases/vapours may be released.
- Consider the use of a work permit system e.g. for maintenance activities.

8.2.2. Individual protection measures, e.g. personal protective equipment

- A risk assessment should be conducted and documented in each work area to assess the risks related to the use of the product and to select the PPE that matches the relevant risk. The following recommendations should be considered:
  - PPE compliant to the recommended EN/ISO standards should be selected.
  - Eye/face protection: Wear goggles and a face shield when transfilling or breaking transfer connections.
    Standard EN 166 - Personal eye-protection - specifications.
  - Skin protection:
    - Hand protection: Wear working gloves when handling gas containers.
      Standard EN 388 - Protective gloves against mechanical risk.
    - Cold insulating gloves when transfilling or breaking transfer connections.
      Standard EN 511 - Cold insulating gloves.
    - Other: Consider the use of flame resistant anti-static safety clothing.
      Wear safety shoes while handling containers.
      Standard EN ISO 20345 - Personal protective equipment - Safety footwear.
  - Respiratory protection: None necessary.
  - Thermal hazards: None in addition to the above sections.

8.2.3. Environmental exposure controls

- Refer to local regulations for restriction of emissions to the atmosphere. See section 13 for specific methods for waste gas treatment.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical state at 20°C / 101.3kPa</td>
<td>Gas</td>
</tr>
<tr>
<td>Colour</td>
<td>Colourless</td>
</tr>
<tr>
<td>Odour</td>
<td>Odourless</td>
</tr>
<tr>
<td>Odour threshold</td>
<td>Odour threshold is subjective and inadequate to warn of overexposure.</td>
</tr>
<tr>
<td>Melting point</td>
<td>-259 °C</td>
</tr>
<tr>
<td>Boiling point</td>
<td>-253 °C</td>
</tr>
<tr>
<td>Flash point</td>
<td>Not applicable for gases and gas mixtures.</td>
</tr>
<tr>
<td>Flammability range</td>
<td>4 - 77 vol %</td>
</tr>
<tr>
<td>Relative vapour density at 20 °C</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>Evaporation rate (ether=1)</td>
<td>Not applicable for gases and gas mixtures.</td>
</tr>
<tr>
<td>Vapour pressure [20°C]</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>Vapour pressure [50°C]</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>Relative density, gas (air=1)</td>
<td>0.07</td>
</tr>
<tr>
<td>Relative density, liquid (water=1)</td>
<td>0.07</td>
</tr>
<tr>
<td>Solubility in water</td>
<td>1.6 mg/l</td>
</tr>
</tbody>
</table>
pH value: Not applicable for gases and gas mixtures.
Partition coefficient n-octanol/water \([\log K_{ow}]\): Not applicable for inorganic gases.
Decomposition point \([^\circ C]\): Not applicable.
Auto-ignition temperature: 560 \(^\circ C\)
Viscosity \([20^\circ C]\): No reliable data available.
Explosive Properties: Not applicable.
Oxidising Properties: Not applicable.

9.2. Other information
Molar mass: 2 g/mol
Critical temperature \([^\circ C]\): -240 \(^\circ C\)
Other data: Burns with an invisible flame.

SECTION 10: Stability and reactivity

10.1. Reactivity
No reactivity hazard other than the effects described in sub-sections below.

10.2. Chemical stability
Stable under normal conditions.

10.3. Possibility of hazardous reactions
Can form explosive mixture with air.
May react violently with oxidants.

10.4. Conditions to avoid
Keep away from heat/sparks/open flames/hot surfaces. – No smoking.
Avoid moisture in installation systems.

10.5. Incompatible materials
Air, Oxidisers.
For additional information on compatibility refer to ISO 11114.
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.

10.6. Hazardous decomposition products
Under normal conditions of storage and use, hazardous decomposition products should not be produced.

SECTION 11: Toxicological information

11.1. Information on toxicological effects
Acute toxicity: No known toxicological effects from this product.
Skin corrosion/irritation: No known effects from this product.
Serious eye damage/irritation: No known effects from this product.
Respiratory or skin sensitisation: No known effects from this product.
Germ cell mutagenicity: No known effects from this product.
Carcinogenicity: No known effects from this product.
Reproductive toxicity:
Toxic for reproduction: Fertility: No known effects from this product.
Toxic for reproduction: unborn child: No known effects from this product.
STOT-single exposure: No known effects from this product.
STOT-repeated exposure: No known effects from this product.
Aspiration hazard: Not applicable for gases and gas mixtures.
SECTION 12: Ecological information

12.1. Toxicity
Assessment : No ecological damage caused by this product.

EC50 48h - Daphnia magna [mg/l] : No data available.
EC50 72h - Algae [mg/l] : No data available.
LC50 96 h - Fish [mg/l] : No data available.

12.2. Persistence and degradability
Assessment : No ecological damage caused by this product.

12.3. Bioaccumulative potential
Assessment : No data available.

12.4. Mobility in soil
Assessment : Because of its high volatility, the product is unlikely to cause ground or water pollution. Partition into soil is unlikely.

12.5. Results of PBT and vPvB assessment
Assessment : No data available.

12.6. Other adverse effects
Other adverse effects : Can cause frost damage to vegetation.
Effect on the ozone layer : None.
Effect on global warming : No known effects from this product.

SECTION 13: Disposal considerations

13.1. Waste treatment methods
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.
Do not discharge into any place where its accumulation could be dangerous.
Ensure that the emission levels from local regulations or operating permits are not exceeded.
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.
Return unused product in original cylinder to supplier.

List of hazardous waste codes (from Commission Decision 2001/118/EC) : 16 05 04 *: Gases in pressure containers (including halons) containing dangerous substances.

13.2. Additional information
External treatment and disposal of waste should comply with applicable local and/or national regulations.

SECTION 14: Transport information

14.1. UN number
UN-No. : 1966

14.2. UN proper shipping name
Transport by road/rail (ADR/RID) : HYDROGEN, REFRIGERATED LIQUID
Transport by air (ICAO-TI / IATA-DGR) : Hydrogen, refrigerated liquid
Transport by sea (IMDG) : HYDROGEN, REFRIGERATED LIQUID

14.3. Transport hazard class(es)

Labelling

2.1 : Flammable gases.

Transport by road/rail (ADR/RID)
Class : 2.
Classification code : 3F.
Hazard identification number : 223.
Tunnel Restriction : B/D - Tank carriage : Passage forbidden through tunnels of category B, C, D and E. Other carriage : Passage forbidden through tunnels of category D and E.

Transport by sea (IMDG)
Class / Div. (Sub. risk(s)) : 2.1
Emergency Schedule (EmS) - Fire : F-D.
Emergency Schedule (EmS) - Spillage : S-U.

14.4. Packing group

Transport by road/rail (ADR/RID) : Not established.
Transport by air (ICAO-TI / IATA-DGR) : Not established.
Transport by sea (IMDG) : Not established.

14.5. Environmental hazards

Transport by road/rail (ADR/RID) : None.
Transport by air (ICAO-TI / IATA-DGR) : None.
Transport by sea (IMDG) : None.

14.6. Special precautions for user

Packing Instruction(s)
Transport by road/rail (ADR/RID) : P203.
Transport by air (ICAO-TI / IATA-DGR) : Forbidden.
Passenger and Cargo Aircraft : Forbidden.
Cargo Aircraft only : Forbidden.
Transport by sea (IMDG) : P203.

Special transport precautions : 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.
Before transporting product containers:
- Ensure there is adequate ventilation.
- Ensure that containers are firmly secured.
- Ensure cylinder valve is closed and not leaking.
- Ensure valve outlet cap nut or plug (where provided) is correctly fitted.
- Ensure valve protection device (where provided) is correctly fitted.

14.7. Transport in bulk according to Annex II of Marpol and the IBC Code

Not applicable.
15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

EU-Regulations

Restrictions on use: None.

National regulations

National legislation: Ensure all national/local regulations are observed.

Germany

Water hazard class (WGK): Water hazard class (WGK) nwg, Non-hazardous to water (Classification according to VwVwS, Annex 1 or 2; ID No. 741)


15.2. Chemical safety assessment

A CSA does not need to be carried out for this product.

SECTION 16: Other information


Abbreviations and acronyms:
ATE - Acute Toxicity Estimate
CLP - Classification Labelling Packaging Regulation; Regulation (EC) No 1272/2008
EINECS - European Inventory of Existing Commercial Chemical Substances
CAS# - Chemical Abstract Service number
PPE - Personal Protection Equipment
LC50 - Lethal Concentration to 50 % of a test population
RMM - Risk Management Measures
PBT - Persistent, Bioaccumulative and Toxic
vPvB - Very Persistent and Very Bioaccumulative
STOT- SE : Specific Target Organ Toxicity - Single Exposure
CSA - Chemical Safety Assessment
EN - European Standard
UN - United Nations
ADR - European Agreement concerning the International Carriage of Dangerous Goods by Road
IATA - International Air Transport Association
IMDG code - International Maritime Dangerous Goods
RID - Regulations concerning the International Carriage of Dangerous Goods by Rail
WGK - Water Hazard Class

Training advice: Ensure operators understand the flammability hazard.

Further information: This Safety Data Sheet has been established in accordance with the applicable European Union legislation.

Full text of H- and EUH-statements

| Flam. Gas 1 | Flammable gases, Category 1 |
| Press. Gas (Ref. Liq.) | Gases under pressure: Refrigerated liquefied gas |
| H220 | Extremely flammable gas. |
| H281 | Contains refrigerated gas; may cause cryogenic burns or injury. |
DISCLAIMER OF LIABILITY:

Before using this product in any new process or experiment, a thorough material compatibility and safety study should be carried out.
Details given in this document are believed to be correct at the time of going to press.
Whilst proper care has been taken in the preparation of this document, no liability for injury or damage resulting from its use can be accepted.