HYPER EMERGENCY PLAN

HYPER HYDROGEN RESEARCH STATION

HYPER-EP-HRS-001

JANUARY 14TH, 2020

AUTHORS:

Elijah Shoemake

Jacob Leachman

Ian Richardson

Last Revision: Tuesday, March 3, 2020 by Bunge, Carl Dale.

1. ABOUT THIS DOCUMENT

This emergency plan has been developed for WSU's Hydrogen Research Station, which is operated as part of the Washington Energy – Cryogenics (WE-Cryo) service center by the Hydrogen Properties for Energy Research (HYPER) Lab. This plan is formatted based on safety plans developed by WSU's HYPER Lab and approved by the Department of Energy (DOE) Hydrogen Safety Panel.

1.1. DOCUMENT SCOPE

The emergency plan was formulated based on the requirements of *NFPA 2: Hydrogen Technologies Code,* Section 4.6. The plan shall include:

- The type of emergency equipment available and the location. (*Section 3 of this document)*
- A brief description of any testing or maintenance programs for the available emergency equipment. *(Section 3 of this document)*
- An indication that hazard identification labeling is provided for each storage area. *(Section 4 of this document)*
- The location of posted emergency procedures. *(Section 6 of this document)*
- A Safety Data sheet (SDS) or equivalent for GH_2 and LH_2 stored or used on the site. *(Section 7 of this document)*
- A list of personnel who are designated and trained to be liaison personnel for the fire department and and who are responsible for the following: *(Section 5 of this document)*
    - Aiding the emergency responders in pre-emergency planning.
    - Identifying the locations of the GH_2 and LH_2 stored or used.
    - Accessing SDSs.
    - Knowing the site emergency procedures.
- A list of the types and quantities of GH_2 and LH_2 found within the facility. *(Section 2 of this document)*

This document will guide the safe conduct of all work and serve as a resource to emergency responders should an emergency response be necessary at this site. The intent of this document is to serve as a general safety resource for this site, but not to document information unique to any particular experiment. Dedicated Safety Plans for every HYPER lab experiment have been developed to cover the unique safety hazards and operational procedures of each experiment.

1.2. UNDERSTANDING THIS DOCUMENT

1.2.1. UNITS

The units of measure in this document are given in U.S. Customary Units (inch-pound units). International System (SI) Units may follow the inch-pound units in parenthesis, at the author's discretion (for example, where a system or part was designed in such units).

1.2.2. CITATIONS

Citations to referenced standards may be given throughout this document to indicate material adopted from or responding to specific standards requirements. These citations will be enclosed in square brackets and consist of a shortened abbreviation of the standard. The section of the standard may be optionally included, separated from the standard abbreviation by a single colon.

For example, *NFPA 2: Hydrogen Technologies Code, 2020 Edition* by the National Fire Protection Association would be referenced in this document by the tag [NFPA 2]. If a reference to the specific section 15.3.1.1.7.2 was needed, the reference would be tagged with [NFPA 2 : 15.3.1.1.7.2].

A list of citations and shortened abbreviations referenced in this document is given in Appendix A.

1.3. CONTENTS

2. SITE INFORMATION

This document was last updated 3/3/2020 1:15:00 PM. As of the time of the last revision of this document, the following experiments are being operated on site:

- The Mobile Hydrogen Generation Unit (MHGU) – A mobile hydrogen production, liquefaction, and dispensing unit designed to refuel unmanned vehicles with liquid hydrogen. This is a mobile piece of research equipment with both gaseous and liquid hydrogen storage on board.

The locations and detailed information for hazards associated with this experiment have been included in the site information in this section. This information shall be updated as experimental operations on the site change. For more information, see each experiment's HYPER Safety Plan.

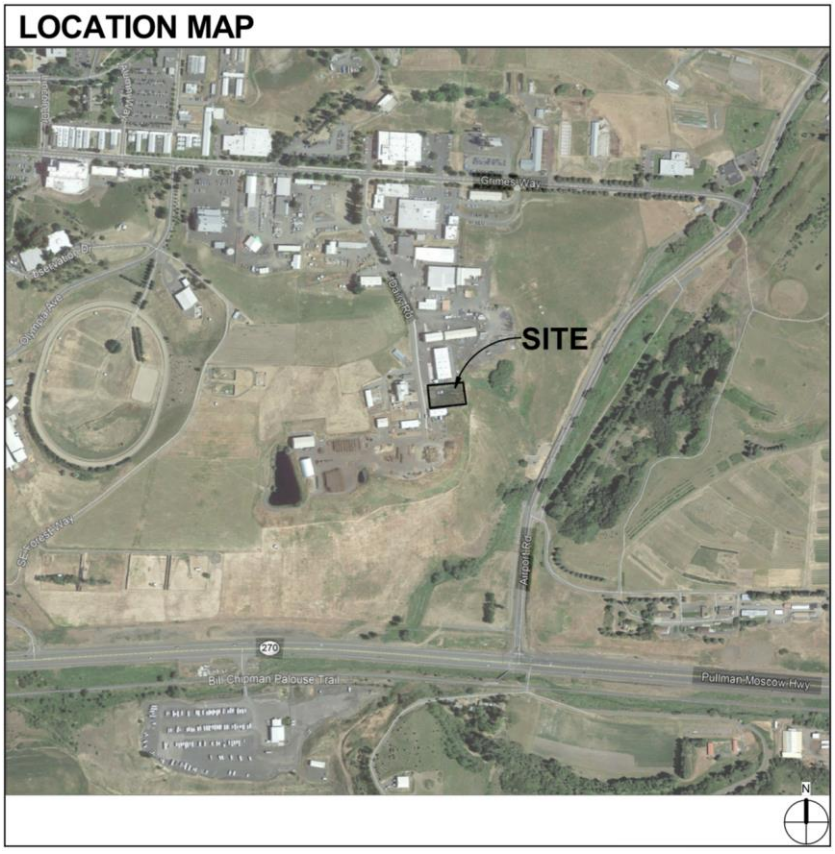
2.1. SITE LOCATION

This test site is located near University Stores on Dairy Road. The address and image of the site location are listed below.

Address:

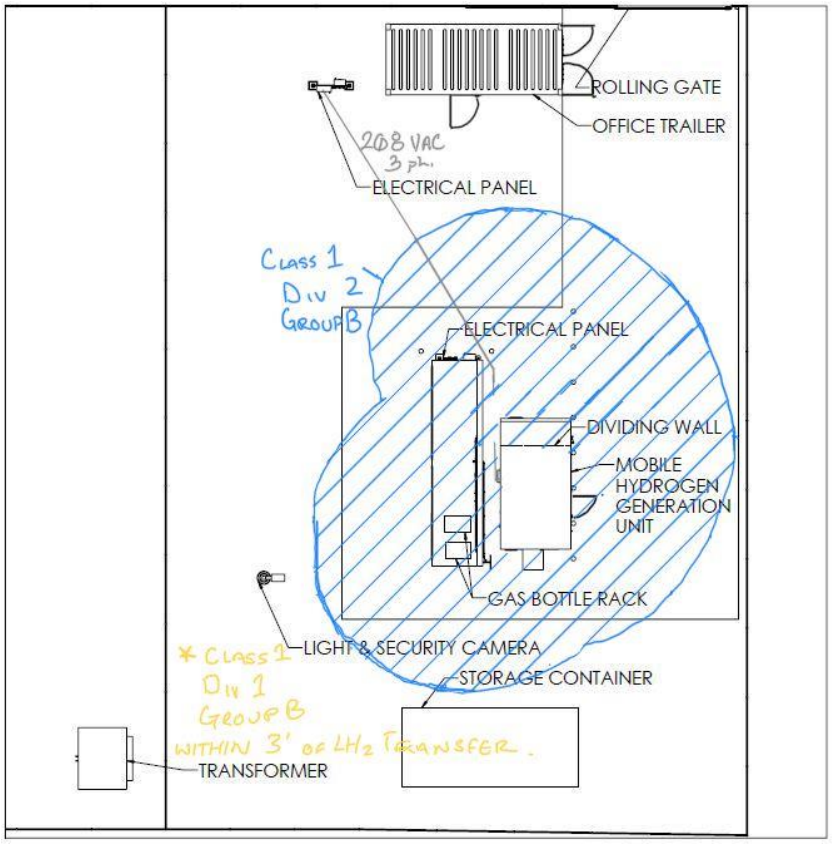
438 SE Dairy Rd.

Pullman, WA 99164



2.2. Site Layout

The layout of this site is shown below. The Mobile Hydrogen Generation Unit (MHGU) is the experiment currently being operated at the site. Please see the MHGU Safety Plan for more information on this experiment and its safety considerations. Due to the nature of the experiment running on the site, sections of the site are electrically classified as Class 1, Division 1, Group B and Class 1, Division 2, Group B. These areas have been shown on the site layout.

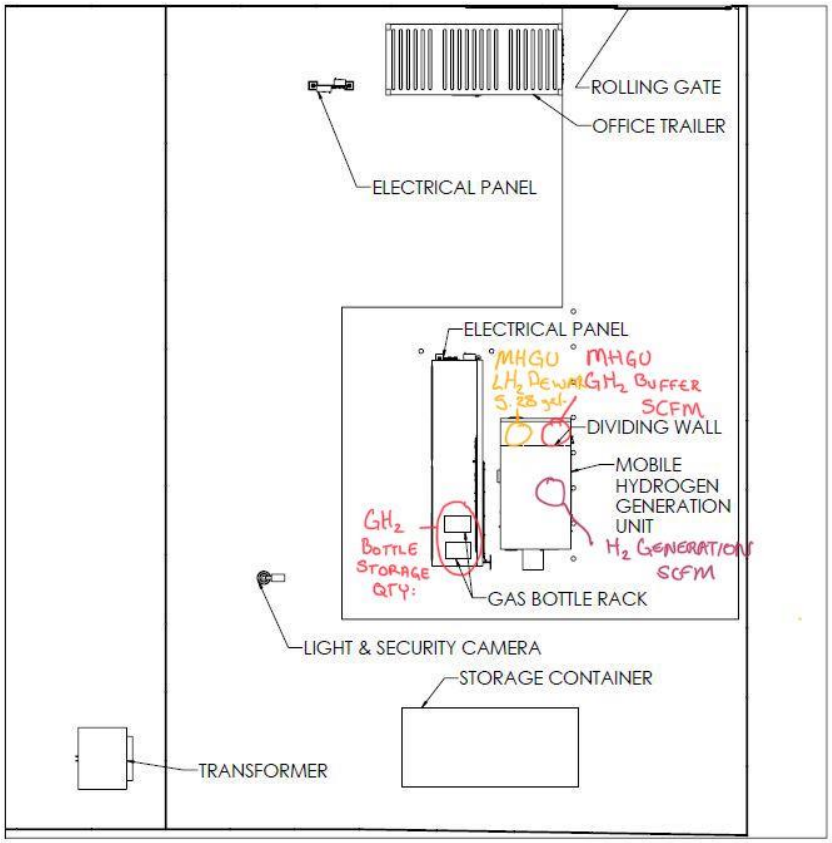


2.3. Locations of Hazards

Hazards on the site are highlighted in the following sections.

2.3.1. Hydrogen Storage

Compressed gaseous hydrogen is stored on the site to fuel experimental operations. In addition, MHGU is currently active on this site and has hydrogen generation included as part of the experiment. Hydrogen is generated by a PEM electrolyzer, travels to the gaseous storage buffer, and is then liquefied in a liquid hydrogen storage dewar. The locations of hydrogen on the site is shown below.



2.4. Site Equipment Testing and Maintenance Programs

Regular testing and maintenance are needed to keep this site operational and up to standards. For ease of implementation and to promote compliance with the maintenance program, the HYPER lab has tried to keep maintenance on an annual or semesterly basis where feasible. This allows the lab to schedule regular time at the beginning of each semester to ensure equipment maintenance is up to date and perform necessary inspections. In some cases, testing, inspection, and/or maintenance is required more often or on an as-needed basis. A clipboard will be attached to the inside office trailer door with a physical log to track maintenance tasks as they occur, and provide detailed instructions on performing maintenance.

This section describes required testing, inspection, and maintenance for the site only. Required testing, inspection, and/or maintenance of safety equipment associated with the site is included in Section 3.2.

2.4.1. Annual Maintenance Tasks

- Confirmation of vent stack grounding per CGA G-5.5. Electrical resistance across the vent stack to ground shall be measured. This resistance value must be less than 10 Ohms.
- Testing of vent stack pressure reliefs. Pressure reliefs on the site plumbing manifold shall be inspected and then tested to cracking pressure. Pressure must be verified to be as rated and indicated on the site P&ID diagram.

2.4.2. Semesterly Maintenance Tasks

- Leak check of all site plumbing. A helium leak check at standard operating pressures should be performed on all site plumbing per ASTM E499/E499M – 11 Test Method A.

2.4.3. As-Needed Maintenance Tasks

- Leak check at bottle swaps. Lines and fittings shall be inspected, and a hydrogen leak checker shall be used to verify bottles are leak-tight every time hydrogen bottles are swapped in/out of the bottle racks on site.
- Leak check after equipment replacement. A helium leak check at standard operating pressures should be performed on site plumbing after repaired, replaced, or changed equipment. Follow ASTM E499/E499M – 11 Test Method A.

3. EMERGENCY EQUIPMENT

3.1. DESCRIPTION OF SAFETY EQUIPMENT

3.1.1. SAFETY DOCUMENTATION

A clearly labeled red binder shall be kept on site containing the Emergency Plan for this site. Similar red binders will be kept on site containing the Safety Plans for each experiment operated on site. These binders shall be stored in the Office Trailer, and should be kept up to date.

3.1.2. FIRE EXTINGUISHERS

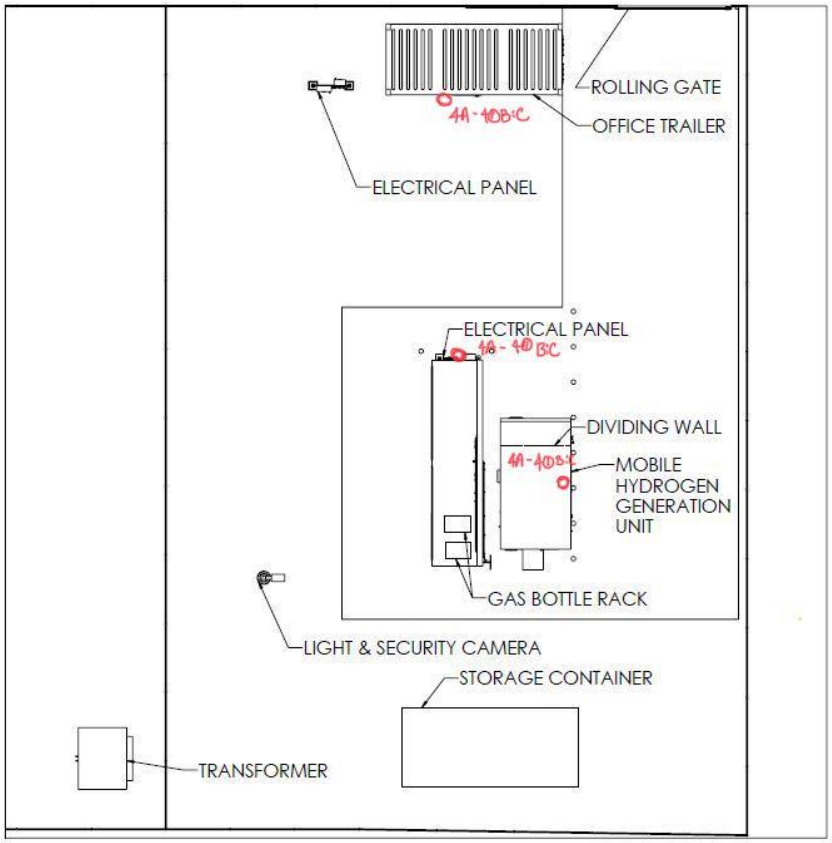
Fire extinguishers for the outdoor test center have been chosen based on recommendations from NFPA 10 and 2. Per NFPA 2, Section 11.2.7, fire extinguishers for a liquid hydrogen fueling facility shall be selected based on NFPA 10 extra (high) hazard requirements for Class B hazards, except that the maximum travel distance to a 80B:C extinguisher shall be permitted to be 100ft. These requirements are given below, from NFPA 10, Table 6.3.1.1 and NFPA 2, Section 11.2.7.

Basic Minimum Extinguisher Rating	Maximum Travel Distance to Extinguishers
40-B	30 ft
80-B	100 ft

Based on this design criterion, we have selected three (3) 4A-40B:C extinguishers to service the site.

3.1.2.1. LOCATIONS

A 4A-40B:C fire extinguisher shall be mounted to the outer wall of the office trailer, the north end of the gas bottle enclosure, and inside the MHGU experiment on site. These locations are shown below.



3.1.3. Personal Protection Equipment (PPE)

The following personal protection equipment is made available on-site and should be used as described in the sections below. In addition to this PPE, all personal visiting or working on the site should wear long pants (no shorts, skirts, or dresses) and meshless closed-toed shoes or boots. Shoes or boots with a meshed or light weave have the potential to soak up liquids and are less damage resistant, and therefore are not satisfactory for site safety.

3.1.3.1. Safety Glasses or Goggles

Safety glasses or goggles are an important piece of safety equipment to protect your eyes from flying debris while working with equipment. Per WSU Policy, safety glasses or googles must be used at all times while working on the site, which is considered a laboratory space.

3.1.3.2. Fire-rated Clothing

NFPA 2112 fire-rated clothing must be worn on site while hydrogen is in use. Clothing should be sufficient to cover both upper and lower body (such as coveralls, bib overalls with jacket, pants and jacket, etc.), as required by NFPA 2113. Hydrogen is considered to be in use at any time when hydrogen is flowing through the gas manifold, within an experiment, or if liquid hydrogen is being stored on site.

3.1.3.3. Cryogenic Gloves

Cryogenic gloves are critical for protecting hands from cryogenic burns while handling cryogenic fluid transfers. Cryogenic gloves will be worn while transferring liquid hydrogen or other cryogens on this site.

3.1.3.4. Face Shields

In addition to safety glasses or goggles, face shields must be worn during cryogenic fluid transfers to protect the face from splashes or spills of cryogenic fluids. Face shields will be worn while transferring liquid hydrogen or other cryogens on this site.

3.1.3.5. Flashlights

Flashlights are present onsite in the event of a power outage at night. If needed, a flashlight may be found mounted outside the office trailer door.

3.1.4. Hydrogen Detection

Hydrogen detection shall be installed on site in the gas bottle storage area. This hydrogen detector will trigger a visible and audible alarm at ¼ the Lower Flammability Limit (LFL), defined at 1% hydrogen by volume. At ½ the LFL (2% hydrogen by volume), this detector shall trigger automatic shutoff of the hydrogen source valves on the gaseous hydrogen storage bottles.

3.1.5. Hydrogen Vents

Dedicated vents for hydrogen have been included on both experiments tested at this site, as well as the hydrogen manifold built into the site gas storage. These hydrogen vents have been designed in accordance with *CGA G-5.5—2014: Hydrogen Vent Systems.* As the standard states, a fire on the vent stack of any hydrogen system is expected and should be considered a design event rather than an emergency. The standard, and thus the design of all vent stacks on the site, has been designed to ensure that operations are safe even in the event of a vent stack fire.

WARNING: As signage at the site indicates, never spray water on a hydrogen vent stack discharge. Cold (up to -423 °F) gaseous hydrogen venting from the stack can instantly freeze water on the outlet and potentially obstruct the discharge area. An obstructed discharge can result in a dangerous pressure build in the system equipment where there is no means to safely release the pressure.

3.1.6. Site Lighting

Lighting is available on site to light the work area when working at night. Be aware that this lighting is tied into facility power and backup power is not provided. In the event of a power outage, flashlights are available to provide alternate lighting. Extreme care should be taken in dark conditions, as ground is uneven in places. Cables, cords, pipes, and other equipment may be on the ground and difficult to see in the dark.

3.2. Safety Equipment Testing and Maintenance Programs

Regular testing and maintenance are needed to keep this site operational and up to standards. For ease of implementation and to promote compliance with the maintenance program, the HYPER lab has tried to keep maintenance on an annual or semesterly basis where feasible. This allows the lab to schedule regular time at the beginning of each semester to ensure maintenance is up to date and perform necessary inspections. In some cases, testing, inspection, and/or maintenance is required more often or on an as-needed basis.

This section describes required testing, inspection, and maintenance for safety and emergency equipment only. Required testing, inspection, and/or maintenance of permanent equipment associated with the site is included in Section 2.4.

3.2.1. Annual Maintenance Tasks

- Hydrogen detector calibration. The hydrogen detector must be calibrated with 1% and 2% hydrogen calibration bottles annually.

3.2.2. Semesterly Maintenance Tasks

- Check emergency flashlight batteries. Ensure the emergency flashlight mounted outside the office trailer door has working batteries by briefly turning on the flashlight. Ensure the flashlight is turned off again when done.
- Calibrate hydrogen detectors. Hydrogen detectors should be recalibrated with 1% and 2% by volume calibrated hydrogen mixtures.

3.2.3. Monthly Maintenance Tasks

- Fire extinguisher inspection. Fire Extinguishers shall be inspected per NFPA 10 at least once a month while this site is in operation. Inspection shall include a check of the following:
    - Location in the designated place
    - Visibility of the extinguisher
    - Access to the extinguisher
    - Pressure gauge reading or indicator is in the operable (green) condition.
    - Fullness determined by hefting

3.2.4. As-Needed Maintenance Tasks

- PPE Replacement. All PPE should be inspected every time before wear. Damaged or worn PPE should not be used, but rather discarded and replaced with new PPE.
- Safety Documentation Update. Any changes to the site shall be coupled with a review of safety documentation, including this Emergency Plan. If changes to the safety documentation are made, updated documents shall be printed and placed in the red safety binders on site. All old safety documentation should be discarded immediately to prevent it from being confused for up-to-date information.

4. HAZARD IDENTIFICATION LABELING

Hazard identification labeling and safety warnings have been provided at several locations on the site. Section 4.1 gives an overview of the types of labeling present on the site and how to read them. The rest of this chapter gives detailed information on the hazard labels placed at locations across the site.

4.1. HOW TO READ HAZARD LABELING.

Most safety warnings and hazard labeling are self-explanatory. Some of the standardized pictographs and hazard information may require explanation and are described in this section.

4.1.1. GHS HAZARD PICTOGRAMS

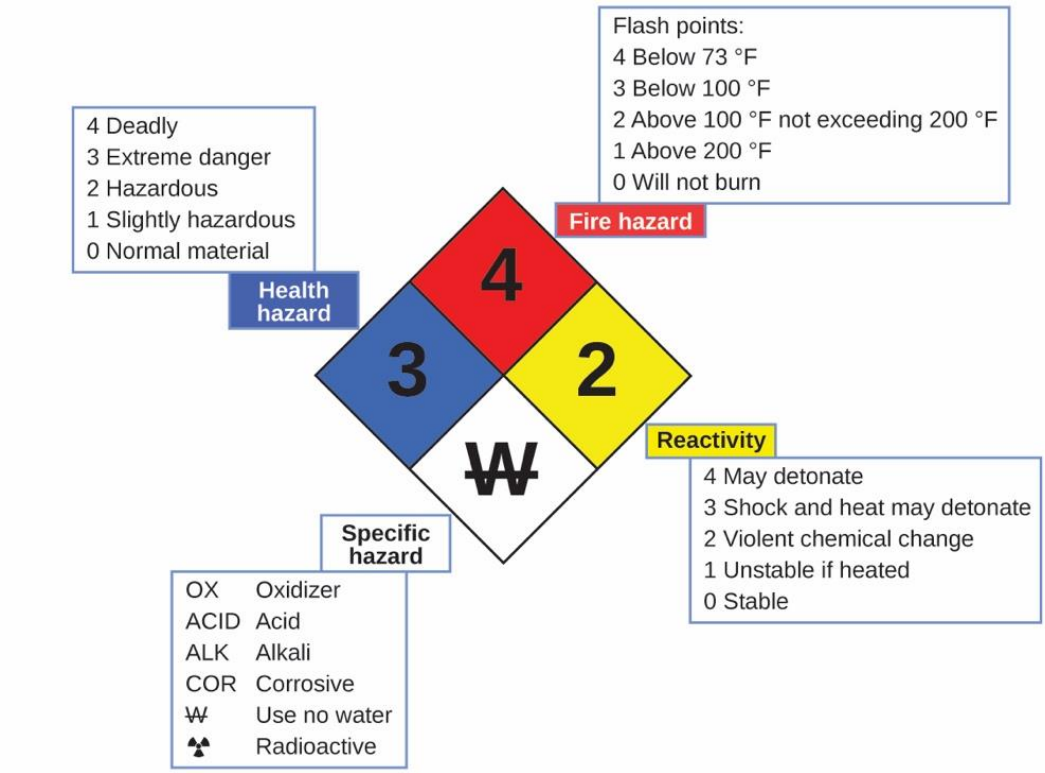
The Global Harmonized System (GHS) for safety and hazard communications is a system developed by the United Nations to standardize safety pictograms and information such that they may be immediately recognizable anywhere in the world. The following GHS pictograms may be used on site to describe hazards.

Pictogram	Description of Pictogram	Locations Onsite Where Pictogram May Be Used
Physical Hazards		
	GHS02: Flammable	Near hydrogen storage areas. This includes gas bottle racks in the gas storage enclosure and liquid hydrogen or gaseous hydrogen buffer storage in experiments on the site.
	GHS04: Compressed Gas	Near gaseous hydrogen, helium, and/or nitrogen storage areas. This includes the gas storage enclosure as well as buffer storage volumes in experiments on site.

More information on GHS pictograms may be found at WSU's Environmental Health & Safety website here: https://ehs.wsu.edu/ohs-chemhazardcommunication/ohs-ghspictograms/.

4.1.2. NFPA HAZARD DIAMOND

The NFPA Hazard Diamond is a standardized method for describing hazards present on a site, described in *NFPA 704: Standard System for the Identification of the Hazards of Materials for Emergency Response*. This is also colloquially known as a "Safety Square" or "Fire Diamond," and is designed to quickly give emergency personnel an indication of the risks posed by hazardous materials on the site.



As can be seen in the diagram above, the left blue square represents a health hazard, the upper red square represents a fire hazard, and the right yellow square represents a reactivity hazard. The hazard rating goes from low to high as numbers go from 0 to 4. A 0 in any square represents no hazard of that type, while a 4 is very dangerous. In the bottom white square, symbols represent specific information that may be important to first responders, such as the presence of oxidizers, strong acids or bases, corrosive materials, water reactive materials, or radioactive materials.

4.2. Main Gate Information

The several signs are posted on the main rolling gate at the entrance to the site, warning about authorized personnel requirements, the NFPA Hazard Diamond rating for the site, and the danger of liquified hydrogen on site. For detailed description of how to read the NFPA Hazard Diamond, see section 4.1.2. These signs indicate the following requirements:

- Only authorized personnel may be present on site.
- No smoking allowed on site.
- No open flames of any kind on site.

4.3. Gas Bottle Storage Identification

The several signs are posted on the main rolling gate at the entrance to the site, warning about authorized personnel requirements, and the NFPA Hazard Diamond rating for the site. For detailed description of how to read the NFPA Hazard Diamond, see section 4.1.2. These signs indicate the following requirements:

- Only authorized personnel may be present on site.

4.4. Hydrogen Vent Stack Information

Hydrogen Vent Stacks are labeled with the sign below, reminding emergency response personnel that water should *never* be sprayed at or down the vent stack when responding to a fire incident.

WARNING: As signage indicates, never spray water on a hydrogen vent stack discharge. Cold (up to -423 °F) gaseous hydrogen venting from the stack can instantly freeze water on the outlet and potentially obstruct the discharge area. Even in cases where cold hydrogen is not present, water can fill the vent stack and cause an obstruction. An obstructed discharge can result in a dangerous pressure build in the system equipment where there is no means to safely release the pressure.


DANGER
DO NOT SPRAY WATER
ON OR IN THE
VENT OPENING

5. SITE COMMUNICATIONS PLAN

5.1. PERSONNEL TRAINING

Personnel must undergo certain trainings before being allowed on site, allowed to perform work on site, or allowed to operate an experiment on site. These requirements are listed in the sections below, and shall be reviewed prior to leaving for the site to ensure all required trainings have been met. Changes to equipment being used, operations being performed, or hazardous materials located on site may change the training requirements. [NFPA 2:4.11.2.7]

5.1.1. BEFORE VISITING THE SITE

HYPER Lab personnel who need to visit the site must go through the HYPER Lab on boarding process and complete all general HYPER Lab trainings, including those required under the terms of their WSU employment. Specific trainings required to visit this site include:

- Hazard Communications Training. [NFPA 2:4.11.1.2] Training shall be provided to enable personnel to recognize and identify hazards, including where compressed or liquified gasses are stored, dispensed, handled, or used on site. Personnel shall also be trained where they can find hazard safety information and how to understand such information and signage.
- Emergency Plan. [NFPA 2:4.11.1.3] This document shall be provided to personnel, and they shall understand its contents, as well as the emergency procedures and Evacuation Plan described in this document.

Guests visiting the site must be accompanied by trained HYPER Lab personnel, and at minimum shall have potential risks and dangers associated with the site explained to them. Guests should be informed of evacuation procedure and instructed to evacuate the site in the event of an emergency.

5.1.2. BEFORE WORKING ON THE SITE

Personnel working on this site must complete the requirements above. In addition, they shall complete additional trainings necessary to complete the work they are intended to do on the site. This includes:

- Physical and Health Hazard Properties. [NFPA 2:4.11.2.2] Personnel shall be trained in the nature of the materials they are using, including possible physical or health hazards and the symptoms of acute or chronic exposure as provided by the SDS. This shall include hydrogen and compressed gas bottle safety trainings if either is to be present on site during the course of work.
- Dispensing, Using and Processing. [NFPA 2:4.11.2.3] Personnel shall be trained in the specific safeguards applicable to the dispensing, processing, or use of any materials or equipment they will need to employ through the course of their work on site.
- Actions in an Emergency. [NFPA 2:4.11.2.6] Personnel shall be trained in the necessary actions to take in the event of an emergency, including the operation and activation of emergency controls prior to evacuation per the Evacuation Plan.

5.1.3. Before Operating an Experiment on this Site

Personnel operating an experiment on this site must complete all requirements above. In addition, they shall complete additional training necessary to work with the hazardous materials necessary to operate the experiment.

- Storage. [NFPA 2:4.11.2.4] Personnel shall be trained in the storage arrangements and site-specific limitations on storage of hydrogen and other hazardous materials on site.
- Transport (Handling). [NFPA 2:4.11.2.5] Personnel shall be trained in how to safely and properly transport materials required for operating the experiment. This includes safe compressed gas bottle transport, handling, and use.
- Safety Plan. Personnel shall have access to, and full understanding of the Safety Plan developed for the experiment. Personnel shall understand all operating and emergency procedures in the Safety Plan. The Safety Plan must be up to date and with a current approval for use prior to operation.

5.2. Project Liaisons

The following sections list contact information for personnel trained to help emergency personnel or an AHJ to better understand this site and procedures to follow in the event of an emergency.

5.2.1. Emergency Response Liaison(s)

Emergency Response Liaisons are persons trained and knowledgeable in the layout, hazards, safety equipment, emergency procedures, and operation of this site. These personnel are expected to be capable of communicating hazards and emergency procedures associated with this site to emergency personnel in the event of an emergency at the site.

Emergency Response Liaisons are expected to be capable of the following: [NFPA 2:4.11.3.2]

- Aid emergency responders in pre-planning responses to emergencies at this site.
- Identify locations where hazardous materials, including GH_2 and LH_2, are located.
- Have access to this document, including all relevant SDSs.
- Be knowledgeable in the information contained in this document, including all site emergency response procedures.

Emergency Response Liaisons for this site are:

Dr. Jacob Leachman
Email: jacob.leachman@wsu.edu
Cell Number: (208) 816-0288
Office Number: (509) 335-7711

Dr. Ian Richardson
Email: irichardson@wsu.edu
Cell Number: (360) 509-8438

5.2.2. EXPERIMENTAL LIAISON(S)

Experimental Liaisons are persons trained and knowledgeable in the hazards, emergency procedures, and operation of an experiment or experiment(s) located at this site. These personnel are expected to be capable of communicating hazards and emergency procedures associated with the experiment they are operating at this site to emergency personnel in the event of an emergency at the site.

Experimental Liaisons are:

Dr. Ian Richardson
Email: irichardson@wsu.edu
Cell Number: (360) 509-8438

THIS PAGE INTENTIONALLY LEFT BLANK.

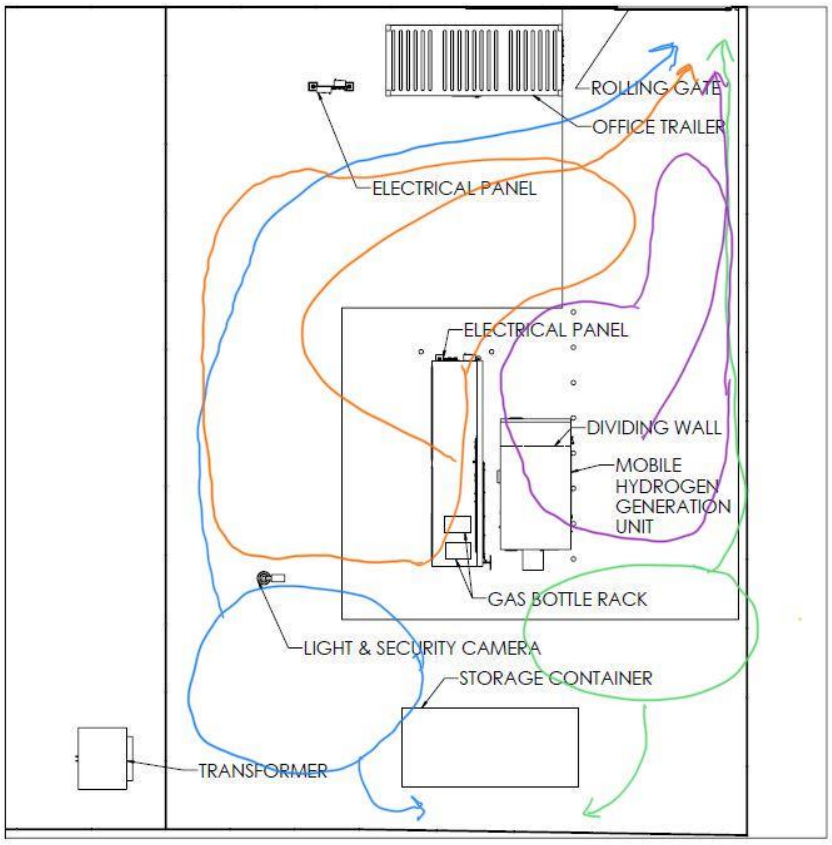
6. EMERGENCY PROCEDURES

This section details the expected emergency response in the event one of the following incidents occurs. In the event of an emergency, always follow the evacuation plan to evacuate non-essential personnel if it is safe to do so. Personnel essential to the safe performance of emergency procedures should follow the relevant emergency procedures if it is safe to do so. Following completion of emergency procedures, these personnel should evacuate to a safe distance and await emergency responders.

These emergency procedures shall be printed and included in a red safety notebook mounted to the inside of the door

6.1. EVACUATION PLAN

In the event evacuation is required by the procedures in this section, in the emergency procedures for the experiment being operated on site, or due to unsafe conditions on site the evacuation plan diagramed below should be followed. People should proceed in an orderly and cautious manner to exit through the rolling gate. If unsafe conditions are present between you and the site, shelter in place behind the steel storage container at the south end of the site until conditions improve.



6.2. Fire

6.2.1. General Fire Information

Hydrogen has a high flammability range and low energy of ignition. As a result, fires are common and expected in the event of hydrogen release or venting. A fire on the vent stack of any of the hydrogen systems should be considered a design event and not an emergency.

The best way to stop an unintended hydrogen fire is to remove the fuel source by shutting of the hydrogen flow at the source valve. Attempts to extinguish a fire before the hydrogen source is shut off or depleted is likely to cause reignition events and may create a detonation on reignition rather than deflagration. Cooling water may be used around the fire on the bulk tank and other equipment but should not be used to extinguish the fire or aimed at the vent stack.

WARNING: As signage at the site indicates, never spray water on a hydrogen vent stack discharge. Cold (up to -423 °F) gaseous hydrogen venting from the stack can instantly freeze water on the outlet and potentially obstruct the discharge area. An obstructed discharge can result in a dangerous pressure build in the system equipment where there is no means to safely release the pressure.

6.2.2. Non-Hydrogen Fire

In the event a fire occurs onsite or near the site, try to keep the fire away from areas containing hydrogen. In the event of danger, follow **Error! Reference source not found. Error! Reference source not found.** to get to a safe distance and wait for emergency response.

- Three fire extinguishers are available on site. Use these to try to put out a fire before it can near hydrogen.
- In the event of a fire, stop operation or venting of hydrogen equipment. Hydrogen generation and hydrogen SOURCE VALVEs should be shut off if possible until the fire is dealt with.

6.2.3. Hydrogen Fire

In the event a hydrogen fire occurs in the onsite equipment, follow the emergency fire procedures specified in the Safety Plan of the associated equipment. In the event of danger, follow **Error! Reference source not found. Error! Reference source not found.** to get to a safe distance and wait for emergency response.

- If it is safe and possible to do so, shut off the SOURCE VALVE and any hydrogen generation onsite in order to starve the fire of fuel.
- Be aware that hydrogen flame can be invisible, especially in bright daylight. Hydrogen also has little radiant heat, meaning you can get very close to a flame without realizing. Treat all hydrogen handling equipment as potentially dangerous in the event of a fire.

6.3. Hydrogen Leak in Onsite Equipment

In the event a hydrogen leak is detected, follow the procedures specified in the Safety Plan of the associated equipment. In the event of danger, follow **Error! Reference source not found. Error! Reference source not found.** to get to a safe distance and wait for emergency response. A leak is likely to be detected by the hydrogen detector on site. Site procedure for responding to hydrogen detected by this detector is as follows:

- 1-2% Hydrogen by volume: Detector will initiate an alarm to indicate the presence of hydrogen. Personnel should be aware of this and monitor the situation. If venting, or otherwise releasing hydrogen intentionally, the intentional hydrogen release should cease until the detector has verified hydrogen concentration has fallen below 1% by volume. Care should be taken if the hydrogen release is restarted to avoid tripping the alarm again.
- 2-4% hydrogen by volume. Detector will continue the alarm and will activate an automated shutoff of the hydrogen source valves in the onsite hydrogen storage. Any other hydrogen source or generation should be shut off. Personnel should prepare for evacuation of the site if the situation does not improve.
- 4+% hydrogen by volume. A hydrogen fire is now a likely event and the site shall be evacuated.

6.4. Weather Events

6.4.1. Lightning

In the event of a nearby lightning storm, the equipment should not be operated. If a run is currently in progress, all additional work should be postponed until the storm abates. Electrical storms could hit the vent stacks on site, causing the potential for dangerous conditions. Any hydrogen leak is at an increased risk of igniting in these conditions.

6.4.2. Temperature Extremes

Work should not be performed in extreme weather with the potential to cause harm to personnel. The temperature limits for work on this site are below.

6.4.2.1. High Temperatures

Work shall not be performed on site in temperatures exceeding 100°F. When work is being performed on this site at high temperatures below this limit, water and electrolytes shall be made available to ensure personnel stay hydrated. Proper care should be taken to avoid sunburn, heat exhaustion, and other dangerous conditions that can occur when working in hot environments.

6.4.2.2. Low Temperatures

Work shall not be performed on site in temperatures below 15°F. When work is being performed on this site at low temperatures above this limit, proper winter clothing should be worn. Personnel should consider that this site is relatively unsheltered and exposed to wind, conditions can seem colder than other parts of campus.

THIS PAGE INTENTIONALLY LEFT BLANK.

7. SAFETY DATA SHEETS

The safety data sheets for hazardous materials used at this site are listed in Appendix B. SDS may be found for the following materials:

- Gaseous Helium
- Gaseous Hydrogen
- Liquid Hydrogen
- Methanol
- Acetone
- 409®
- Windex®

A complete list of all the SDS for the entire HYPER lab may be found in TFRB 108B, above the chemical cabinet. SDSs are also stored in the files for the Safety Channel on Microsoft Teams.

THIS PAGE INTENTIONALLY LEFT BLANK.

8. CHANGELOG

8.1. 2020-01-14 – DOCUMENT ADAPTATION

This document has been adapted from the December 12th, 2019 revision of the MHGU Safety Plan by The Protium Company under WSU Contract 28512. The formatting of the document was kept from the MHGU Safety Plan, however the contents have been updated to meet the guidelines in *NFPA 2: Hydrogen Technologies Code, 2020 Edition* section 4.6.

8.2. 2020-02-27 – NAME CHANGE, FINALIZATION

This document has changed name from the We-CRYO Outdoor Test Center to the HYPER Hydrogen Research Station, and the corresponding document number has changed to HYPER-EP-HRS-001. This is to represent the site more uniformly across all of HYPER's documentation. Additionally, items from final review with Dr. Jake Leachman and arising from site/MHGU HAZOP process were tweaked and added across the document to finalize the initial revision of this document. SDS documents were moved to Appendix B, while the list of SDS made available was kept in chapter 7.

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDICES

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX A: REFERENCE CITATIONS

A.1 STANDARDS USED

The following standards have been used in creating this document and the emergency procedures developed for this site. Shortened abbreviations for the reference of each standard are given in square brackets before each standard in the list.

- [CGA G-5.5] *CGA G-5.5—2014: Hydrogen Vent Systems*
- [CGA S-1.1] *CGA S-1.1—2019: Pressure Relief Device Standards—Part 1—Cylinders for Compressed Gases*
- [CGA S-1.2] *CGA S-1.2—2019: Pressure Relief Device Standards —Part 2—Portable Containers for Compressed Gasses*
- [CGA S-1.3] CGA *S-1.3—2008: Pressure Relief Device Standards—Part 3—Stationary Storage Containers for Compressed Gasses*
- [NFPA 2] *NFPA 2: Hydrogen Technologies Code, 2020 Edition*
- [NFPA 10] *NFPA 10: Standard for Portable Fire Extinguishers, 2018 Edition*
- [NFPA 55] *NFPA 55: Compressed Gases and Cryogenic Fluids Code, 2020 Edition*
- [NFPA 704] *NFPA 704: Standard System for the Identification of the Hazards of Materials for Emergency Response, 2017 Edition*
- [NFPA 2112] *NFPA 2112: Standard on Flame-Resistant Clothing for Protection of Industrial Personnel Against Short-Duration Thermal Exposures from Fire, 2018 Edition*
- [NFPA 2113] *NFPA 2113: Standard on Selection, Care, Use, and Maintenance of Flame-Resistant Garments for Protection of Industrial Personnel Against Short-Duration Thermal Exposures from Fire, 2020 Edition*

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX B: SAFETY DATA SHEETS (SDSS)

B.1 HELIUM SDS

ADVANCED SPECIALTY GASES®

Safety Data Sheet
Helium

www.advancedspecialtygases.com

Section 1: Product and Company Identification

Advanced Specialty Gases
135 Catron Dr. Reno, NV 89512
775-356-5500

Product Code: Helium

Section 2: Hazards Identification

Warning

Hazard Classification:
Gases Under Pressure

Hazard Statements:
Contains gas under pressure; may explode if heated

Precautionary Statements

Storage:
Protect from sunlight.
Store in well-ventilated place.

Section 3: Composition/Information on Ingredients

CAS #
7440-59-7

Chemical Substance	Chemical Family	Trade Names

Chemical Substance	Chemical Family	Trade Names
HELIUM	inorganic, gas	HELIUM GAS; HELIUM COMPRESSED; HELIUM-4; ATOMIC HELIUM; UN 1046; He

Section 4: First Aid Measures

Skin Contact	Eye Contact	Ingestion	Inhalation	Note to Physicians
Wash exposed skin with soap and water.	Flush eyes with plenty of water.	If a large amount is swallowed, get medical attention.	If adverse effects occur, remove to uncontaminated area. Give artificial respiration if not breathing. If breathing is difficult, oxygen should be administered by qualified personnel. Get immediate medical attention.	For inhalation, consider oxygen.

Section 5: Fire Fighting Measures

Suitable Extinguishing Media	Products of Combustion	Protection of Firefighters
Non-flammable. Use suitable extinguishing media for surrounding fire.	Non-flammable	▪ Non-flammable ▪ Non-flammable

Section 6: Accidental Release Measures

Personal Precautions	Environmental Precautions	Methods for Containment
Keep unnecessary people away, isolate hazard area and deny entry. Stay upwind and keep out of low areas.	Avoid soil, waterways, drains and sewers	Stop leak if possible without personal risk.

Methods for Cleanup	Other Information
Stop leak, evacuate area. Contact emergency personnel.	None

Section 7: Handling and Storage

Handling	Storage
Store and handle in accordance with all current regulations and standards. Subject to storage regulations: U.S. OSHA 29 CFR 1910.101.	Keep separated from incompatible substances.

Section 8: Exposure Controls/Personal Protection

Exposure Guidelines
HELIUM: ACGIH (simple asphyxiant)

Engineering Controls

Handle only in fully enclosed systems.

Eye Protection	Skin Protection	Respiratory Protection
Eye protection not required, but recommended.	Protective clothing is not required.	Non-flammable

General Hygiene considerations

- Avoid breathing vapor or mist
- Avoid contact with eyes and skin
- Wash thoroughly after handling and before eating or drinking

Section 9: Physical and Chemical Properties

Physical State	Appearance	Color	Change in Appearance	Physical Form	Odor	Taste

Physical State	Appearance	Color	Change in Appearance	Physical Form	Odor	Taste
Gas	Colorless	Colorless	N/A	Gas	Odorless	Tasteless

Flash Point	Flammability	Partition Coefficient	Autoignition Temperature	Upper Explosive Limits	Lower Explosive Limits
Not flammable	Not available	Not available	Nonflammable	Nonflammable	Nonflammable

Boiling Point	Freezing Point	Vapor Pressure	Vapor Density	Specific Gravity	Water Solubility	pH	Odor Threshold	Evaporation Rate	Viscosity
-452 F (-269 C)	-458 F (-272 C) @ 26 atm	1719 mmHg @ -268 C	0.138 (Air=1)	Not applicable	0.94% @ 0 C	Not applicable	Not available	Not applicable	0.02012 cP @ 26.8 C

Molecular Weight	Molecular Formula	Density	Weight per Gallon	Volatility by Volume	Volatility	Solvent Solubility
4.0026	He	0.1785 g/L @ 0 C	Not available	100%	Not applicable	Insoluble: Not available

Section 10: Stability and Reactivity

Stability	Conditions to Avoid	Incompatible Materials
Stable at normal temperatures and pressure.	Stable at normal temperatures and pressure.	No data available.

Hazardous Decomposition Products	Possibility of Hazardous Reactions
Miscellaneous decomposition products	Will not polymerize.

Section 11: Toxicology Information

Acute Effects

Oral LD50	Dermal LD50	Inhalation
Not available	Not available	Nausea, vomiting, difficulty breathing, irregular heartbeat, headache, fatigue, dizziness, disorientation, emotional disturbances, tingling sensation, loss of coordination, suffocation, convulsions, unconsciousness, coma

Eye Irritation	Skin Irritation	Sensitization
Liquid: frostbite, blurred vision	Liquid: frostbite	Difficulty breathing

Chronic Effects

Carcinogenicity	Mutagenicity	Reproductive Effects	Developmental Effects
Not available	Not available	Not available	No data

Section 12: Ecological Information

Fate and Transport

Eco toxicity	Persistence / Degradability	Bioaccumulation / Accumulation	Mobility in Environment
Fish toxicity: Not available **Invertibrate toxicity: Not available** **Algal toxicity: Not available** **Phyto toxicity: Not available** **Other toxicity: Not available**	Not available	Not available	Not available

Section 13: Disposal Considerations

Dispose in accordance with all applicable regulations.

Section 14: Transportation Information

U.S. DOT 49 CFR 172.101

Proper Shipping Name	ID Number	Hazard Class or Division	Packing Group	Labeling Requirements	Passenger Aircraft or Railcar Quantity Limitations	Cargo Aircraft Only Quantity Limitations	Additional Shipping Description
Helium, compressed	UN1046	2.2	Not applicable	2.2	75 kg or L	150 kg	N/A

Canadian Transportation of Dangerous Goods

Shipping Name	UN Number	Class	Packing Group / Risk Group
Helium, compressed	UN1046	2.2	Not applicable

Section 15: Regulatory Information

U.S. Regulations

CERCLA Sections	SARA 355.30	SARA 355.40
Not regulated.	Not regulated.	Not regulated.

SARA 370.21

Acute	Chronic	Fire	Reactive	Sudden Release
Yes	No	No	No	Yes

SARA 372.65

Not regulated.

OSHA Process Safety

Not regulated.

State Regulations

CA Proposition 65
Not regulated.

Canadian Regulations

WHMIS Classification
A

National Inventory Status

US Inventory (TSCA)	TSCA 12b Export Notification	Canada Inventory (DSL/NDSL)
Listed on inventory.	Not listed.	Not determined.

Section 16: Other Information

NFPA Rating
HEALTH=0 FIRE=0 REACTIVITY=0

0 = minimal hazard, 1 = slight hazard, 2 = moderate hazard, 3 = severe hazard, 4 = extreme hazard

B.2 HYDROGEN SDS

ADVANCED SPECIALTY GASES®

Safety Data Sheet
Hydrogen

www.advancedspecialtygases.com

Section 1: Product and Company Identification

Advanced Specialty Gases
135 Catron Dr. Reno, NV 89512
775-356-5500

Product Code: Hydrogen

Section 2: Hazards Identification

Danger

Hazard Classification:
Flammable (Category 1)
Gases Under Pressure

Hazard Statements:
Contains gas under pressure; may explode if heated
Extremely flammable gas

Precautionary Statements
Prevention:
Keep away from heat/sparks/open flames/hot surfaces. - No smoking.

Response:
Eliminate all ignition sources if safe to do so.
Leaking gas fire: Do not extinguish, unless leak can be stopped safely.

Storage:
Protect from sunlight.
Store in well-ventilated place.

Section 3: Composition/Information on Ingredients

CAS #
1333-74-0

Chemical Substance	Chemical Family	Trade Names
HYDROGEN	inorganic, gas	HYDROGEN GAS; HYDROGEN COMPRESSED; HYDROGEN (H2); DIHYDROGEN; UN 1049; H2

Section 4: First Aid Measures

Skin Contact	Eye Contact	Ingestion	Inhalation	Note to Physicians
Wash exposed skin with soap and water.	Flush eyes with plenty of water.	If a large amount is swallowed, get medical attention.	If adverse effects occur, remove to uncontaminated area. Give artificial respiration if not breathing. If breathing is difficult, oxygen should be administered by qualified personnel. Get immediate medical attention.	For inhalation, consider oxygen.

Section 5: Fire Fighting Measures

Suitable Extinguishing Media	Products of Combustion	Protection of Firefighters
Carbon dioxide, regular dry chemical Large fires: Flood with fine water spray.	None known	▪ Any self-contained breathing apparatus with a full facepiece. ▪ Any self-contained breathing apparatus with a full facepiece.

Section 6: Accidental Release Measures

Personal Precautions	Environmental Precautions	Methods for Containment
Keep unnecessary people away, isolate hazard area and deny entry. Do not touch spilled material. Ventilate closed spaces before entering.	Avoid heat, flames, sparks and other sources of ignition.	Reduce vapors with water spray. Remove sources of ignition.

Methods for Cleanup	Other Information
Stop leak if possible without personal risk.	None

Section 7: Handling and Storage

Handling	Storage
Store and handle in accordance with all current regulations and standards. Grounding and bonding required. Subject to storage regulations: U.S. OSHA 29 CFR 1910.101.	Keep separated from incompatible substances.

Section 8: Exposure Controls/Personal Protection

Exposure Guidelines
HYDROGEN: ACGIH (simple asphyxiant)

Engineering Controls

Handle only in fully enclosed systems.

Eye Protection	Skin Protection	Respiratory Protection
Eye protection not required, but recommended.	Protective clothing is not required.	Any self-contained breathing apparatus with a full facepiece.

General Hygiene considerations

- Avoid breathing vapor or mist
- Avoid contact with eyes and skin
- Wash thoroughly after handling and before eating or drinking

Section 9: Physical and Chemical Properties

Physical State	Appearance	Color	Change in Appearance	Physical Form	Odor	Taste
Gas	Colorless	Colorless	N/A	Gas	Odorless	Tasteless

Flash Point	Flammability	Partition Coefficient	Autoignition Temperature	Upper Explosive Limits	Lower Explosive Limits
Flammable gas (burns at all ambient temperatures)	Not available	Not available	752 F (400 C)	0.75	0.04

Boiling Point	Freezing Point	Vapor Pressure	Vapor Density	Specific Gravity	Water Solubility	pH	Odor Threshold	Evaporation Rate	Viscosity
-423 F (-253 C)	-434 F (-259 C)	760 mmHg @ -253 C	0.07 (Air=1)	Not applicable	1.82% @ 20 C	Not applicable	Not available	Not applicable	0.008957 cP @ 26.8 C

Molecular Weight	Molecular Formula	Density	Weight per Gallon	Volatility by Volume	Volatility	Solvent Solubility
2	H2	0.08987 g/L @ 0 C	Not available	Not available	Not applicable	Soluble: Not available

Section 10: Stability and Reactivity

Stability	Conditions to Avoid	Incompatible Materials
Stable at normal temperatures and pressure.	Stable at normal temperatures and pressure.	Metals, oxidizing materials, metal oxides, combustible materials, halogens, metal salts, halo carbons, nitrogen triflouride, oxygen diflouride, magnesium and calcium carbonate, sodium, potassium

Hazardous Decomposition Products	Possibility of Hazardous Reactions
Miscellaneous decomposition products	Will not polymerize.

Section 11: Toxicology Information

Acute Effects

Oral LD50	Dermal LD50	Inhalation
Not available	Not available	Nausea, vomiting, difficulty breathing, irregular heartbeat, headache, fatigue, dizziness, disorientation, mood swings, tingling sensation, loss of coordination, convulsions, unconsciousness, coma

Eye Irritation	Skin Irritation	Sensitization
Not irritating	Not irritating	Difficulty breathing

Chronic Effects

Carcinogenicity	Mutagenicity	Reproductive Effects	Developmental Effects
Not available	Not available	Not available	No data

Section 12: Ecological Information

Fate and Transport

Eco toxicity	Persistence / Degradability	Bioaccumulation / Accumulation	Mobility in Environment
Fish toxicity: Not available	Not available	Not available	Not available

Invertibrate toxicity: Not available **Algal toxicity: Not available** **Phyto toxicity: Not available** **Other toxicity: Not available**			

Section 13: Disposal Considerations

Dispose in accordance with all applicable regulations. Subject to disposal regulations: U.S. EPA 40 CFR 262. Hazardous Waste Number(s): D001.

Section 14: Transportation Information

U.S. DOT 49 CFR 172.101

Proper Shipping Name	ID Number	Hazard Class or Division	Packing Group	Labeling Requirements	Passenger Aircraft or Railcar Quantity Limitations	Cargo Aircraft Only Quantity Limitations	Additional Shipping Description
Hydrogen, compressed	UN1049	2.1	Not applicable	2.1	Forbidden	150 kg	None

Canadian Transportation of Dangerous Goods

Shipping Name	UN Number	Class	Packing Group / Risk Group
Hydrogen, compressed	UN1049	2.1	Not applicable

Section 15: Regulatory Information

U.S. Regulations

CERCLA Sections	SARA 355.30	SARA 355.40
Not regulated.	Not regulated.	Not regulated.

SARA 370.21

Acute	Chronic	Fire	Reactive	Sudden Release
Yes	No	Yes	No	Yes

SARA 372.65

Not regulated.

OSHA Process Safety

Not regulated.

State Regulations

CA Proposition 65
Not regulated.

Canadian Regulations

WHMIS Classification
A, B1.

National Inventory Status

US Inventory (TSCA)	TSCA 12b Export Notification	Canada Inventory (DSL/NDSL)
Listed on inventory.	Not listed.	Listed on inventory.

Section 16: Other Information

NFPA Rating
HEALTH=0 FIRE=4 REACTIVITY=0

0 = minimal hazard, 1 = slight hazard, 2 = moderate hazard, 3 = severe hazard, 4 = extreme hazard

B.3 LIQUID HYDROGEN SDS

AIR PRODUCTS

Safety Data Sheet

Version 1.12 SDS Number 300000000075
Revision Date 08/01/2016 Print Date 01/18/2020

1. PRODUCT AND COMPANY IDENTIFICATION

Product name	:	Hydrogen (Refrigerated)
Chemical formula	:	H2
Synonyms	:	Hydrogen (refrigerated), Cryogenic Liquid Hydrogen, Liquid Hydrogen
Product Use Description	:	General Industrial
Manufacturer/Importer/Distributor	:	Air Products and Chemicals, Inc 7201 Hamilton Blvd. Allentown, PA 18195-1501 GST No. 123600835 RT0001 QST No. 102753981 TQ0001
Telephone	:	1-610-481-4911 Corporate 1-800-224-2724 CSO
Emergency telephone number (24h)	:	800-523-9374 USA +1 610 481 7711 International

2. HAZARDS IDENTIFICATION

GHS classification

Flammable gases - Category 1
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.
May displace oxygen and cause rapid suffocation.
May form explosive mixtures in air.
Burns with invisible flame.

Precautionary Statements:

Prevention	:	P210:Keep away from heat, hot surfaces, sparks, open flames, and other ignition sources. No smoking.
Response	:	P377 :Leaking gas fire: Do not extinguish, unless leak can be stopped safely. P381 :Eliminate all ignition sources if safe to do so.
Storage	:	P410+P403:Protect from sunlight. Store in a well-ventilated place.

Hazards not otherwise classified

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).

100 % of mixture consists of ingredients of unknown acute toxicity

3. COMPOSITION/INFORMATION ON INGREDIENTS

Components	CAS Number	Concentration (Volume)
Hydrogen	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.
Most important symptoms/effects - acute and delayed	:	Exposure to oxygen deficient atmosphere may cause the following symptoms: Dizziness. Salivation. Nausea. Vomiting. Loss of mobility/consciousness.

Immediate Medical Attention and Special Treatment

Treatment	:	If exposed or concerned: Get medical attention/advice.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media	:	All known extinguishing media can be used.
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. Keep area evacuated and free from ignition sources until any spilled liquid has evaporated. (Ground free from frost). 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	:	Wear self contained breathing apparatus for fire fighting if necessary.
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, Protective Equipment, and Emergency Procedures	:	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. All piped systems and associated equipment must b e grounded.

Storage

Do not change or force fit connections. Always keep container in upright position. Use a back flow preventative device in the piping. Use insulated hose and piping to prevent condensation of oxygen-rich liquid air. Open/close valve slowly. Close when not in use. Wear Safety Eye Protection. Check Safety Data Sheet before use. 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. Users of breathing apparatus must be trained. Self contained breathing apparatus (SCBA) or positive pressure airline with mask are to be used in oxygen-deficient atmosphere.
Hand protection	:	Wear working gloves when handling gas containers. Loose fitting thermal insulated or leather gloves. Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary.
Eye protection	:	Safety glasses recommended when handling cylinders. Wear goggles and a face shield when transfilling or breaking transfer connections.
Skin and body protection	:	Safety shoes are recommended when handling cylinders. Flame retardant protective clothing. 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.
Special instructions for protection and hygiene	:	Ensure adequate ventilation, especially in confined areas.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	:	Liquefied gas. Colorless.
Odor	:	None.
Odor threshold	:	No data available.
pH	:	Not applicable.
Melting point/range	:	-434 °F (-259 °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	:	75 %(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)	:	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.
Materials to avoid	:	Oxygen. Oxidizing agents. Carbon steel.
Hazardous decomposition products	:	Under normal conditions of storage and use, hazardous decomposition products should not be produced.
Possibility of hazardous Reactions/Reactivity	:	No data available.

11. TOXICOLOGICAL INFORMATION

11.1. Information on toxicological effects

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.
Skin corrosion/irritation	:	No data available.
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.

Delayed and Immediate Effects and Chronic Effects from Short and Long Term Exposure

None.Not applicable.

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)".

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.
Contaminated packaging	:	Return cylinder to supplier.

14. TRANSPORT INFORMATION

DOT

UN/ID No.	:	UN1966
Proper shipping name	:	Hydrogen, refrigerated liquid
Class or Division	:	2.1
Label(s)	:	2.1
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

TDG

UN/ID No.	:	UN1966
Proper shipping name	:	HYDROGEN, REFRIGERATED LIQUID
Class or Division	:	2.1
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

Toxic Substance Control Act (TSCA) 12(b) Component(s):

None.

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.

EPA SARA Title III Section 312 (40 CFR 370) Hazard Classification
Fire Hazard. Sudden Release of Pressure Hazard.

US. California Safe Drinking Water & Toxic Enforcement Act (Proposition 65)
This product does not contain any chemicals known to State of California to cause cancer, birth defects or any other harm.

Safety Data Sheet

Version 1.12 SDS Number 300000000075
Revision Date 08/01/2016 Print Date 01/18/2020

16. OTHER INFORMATION

NFPA Rating

Health	:	3
Fire	:	4
Instability	:	0

HMIS Rating

Health	:	3
Flammability	:	4
Physical hazard	:	1

Prepared by	:	Air Products and Chemicals, Inc. Global EH&S Product Safety Department
Telephone	:	1-610-481-4911 Corporate 1-800-224-2724 CSO
Preparation Date	:	01/18/2020

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

B.4 METHANOL SDS

Version: 1.2
Revision Date: 03-05-2015

SAFETY DATA SHEET

1. Identification

Product identifier: Methanol

Other means of identification
Synonyms: Methyl Alcohol
Product No.: 3042, 9124, 3292, 3290, 6290, 8820, 9424, 9423, 9098, 9097, 9077, 9076, 9073, 9070, 9069, 9067, 9066, 9063, 9049, 8888, 8818, 8814, 9093, 9065, V184, 3041, 3017, 3004, H603, H488, H080, 5842, 3016, 9863, 9830, 5595, 5370, 9263, 72690, 12210

Recommended use and restriction on use
Recommended use: Not available.
Restrictions on use: Not known.

Manufacturer/Importer/Supplier/Distributor Information

Manufacturer

Company Name:	Avantor Performance Materials, Inc.
Address:	3477 Corporate Parkway, Suite 200 Center Valley, PA 18034
Telephone:	Customer Service: 855-282-6867
Fax:	
Contact Person:	Environmental Health & Safety
e-mail:	info@avantormaterials.com

Emergency telephone number:
24 Hour Emergency: 908-859-2151

Chemtrec: 800-424-9300

2. Hazard(s) identification

Hazard Classification

Physical Hazards

Flammable liquids	Category 2

Health Hazards

Acute toxicity (Oral)	Category 3
Acute toxicity (Dermal)	Category 3
Acute toxicity (Inhalation - vapor)	Category 3
Skin Corrosion/Irritation	Category 2
Serious Eye Damage/Eye Irritation	Category 2A
Toxic to reproduction	Category 2
Specific Target Organ Toxicity - Single Exposure	Category 1

Label Elements
Hazard Symbol:

Signal Word:	Danger
Hazard Statement:	Toxic in contact with skin. Toxic if inhaled. Toxic if swallowed. Highly flammable liquid and vapor. Causes skin irritation. Causes serious eye irritation. Suspected of damaging fertility or the unborn child. Causes damage to organs.
Precautionary Statement	
Prevention:	Obtain special instructions before use. Do not breathe dust/fume/gas/mist/vapors/spray. Do not handle until all safety precautions have been read and understood. Wear protective gloves/protective clothing/eye protection/face protection. Keep away from heat/sparks/open flames/hot surfaces. No smoking. Keep container tightly closed. Ground/bond container and receiving equipment. Use explosion-proof electrical/ventilating/lighting/equipment. Use only non-sparking tools. Take precautionary measures against static discharge.
Response:	IF exposed or concerned: Get medical advice/attention. IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. IF INHALED: Remove person to fresh air and keep comfortable for breathing. IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician.
Storage:	Store in a well-ventilated place. Keep cool. Store locked up.
Disposal:	Dispose of contents/container to an appropriate treatment and disposal facility in accordance with applicable laws and regulations, and product characteristics at time of disposal.
Other hazards which do not result in GHS classification:	Static accumulating flammable liquid can become electrostatically charged even in bonded and grounded equipment. Sparks may ignite liquid and vapor. May cause flash fire or explosion.

3. Composition/information on ingredients

Substances

Chemical Identity	Common name and synonyms	CAS number	Content in percent (%)*
METHYL ALCOHOL		67-56-1	99 - 100%

* All concentrations are percent by weight unless ingredient is a gas. Gas concentrations are in percent by volume.

4. First-aid measures

General information:	Get medical advice/attention if you feel unwell. Show this safety data sheet to the doctor in attendance.
Ingestion:	Call a physician or poison control center immediately. Do NOT induce vomiting. If vomiting occurs, keep head low so that stomach content doesn't get into the lungs.

Inhalation:	Move to fresh air. Call a physician or poison control center immediately. If breathing stops, provide artificial respiration. If breathing is difficult, give oxygen.
Skin Contact:	Immediately flush with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Call a physician or poison control center immediately. Wash contaminated clothing before reuse. Destroy or thoroughly clean contaminated shoes.
Eye contact:	Immediately flush with plenty of water for at least 15 minutes. If easy to do, remove contact lenses. Get medical attention.

Most important symptoms/effects, acute and delayed

Symptoms:	Toxic if inhaled. Toxic if swallowed. Toxic in contact with skin. Irritating to eyes, respiratory system and skin.

Indication of immediate medical attention and special treatment needed

Treatment:	Treat symptomatically. Symptoms may be delayed.

5. Fire-fighting measures

General Fire Hazards:	Static charges generated by emptying package in or near flammable vapor may cause flash fire.

Suitable (and unsuitable) extinguishing media

Suitable extinguishing media:	Water spray, foam, dry powder or carbon dioxide.
Unsuitable extinguishing media:	Avoid water in straight hose stream; will scatter and spread fire.
Specific hazards arising from the chemical:	Can be ignited easily and burns vigorously. Vapor from the solvent may accumulate in container headspace resulting in flammability hazard. Fire may produce irritating, corrosive and/or toxic gases.

Special protective equipment and precautions for firefighters

Special fire fighting procedures:	Use water spray to keep fire-exposed containers cool. Fight fire from a protected location. Move containers from fire area if you can do so without risk. Cool containers exposed to flames with water until well after the fire is out.
Special protective equipment for fire-fighters:	Firefighters must use standard protective equipment including flame retardant coat, helmet with face shield, gloves, rubber boots, and in enclosed spaces, SCBA. Withdraw immediately in case of rising sound from venting safety device or any discoloration of tanks due to fire.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures:	Use personal protective equipment. Keep unauthorized personnel away. Keep upwind. Ventilate closed spaces before entering them. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. See Section 8 of the SDS for Personal Protective Equipment.

Methods and material for containment and cleaning up:	Eliminate all ignition sources if safe to do so. Use only non-sparking tools. All equipment used when handling the product must be grounded. Absorb spill with vermiculite or other inert material, then place in a container for chemical waste. Clean surface thoroughly to remove residual contamination. Dike far ahead of larger spill for later recovery and disposal.
Notification Procedures:	Dike for later disposal. Prevent entry into waterways, sewer, basements or confined areas. Stop the flow of material, if this is without risk. Inform authorities if large amounts are involved.
Environmental Precautions:	Do not contaminate water sources or sewer. Prevent further leakage or spillage if safe to do so. Avoid discharge into drains, water courses or onto the ground.

7. Handling and storage

Precautions for safe handling:	DO NOT handle, store or open near an open flame, sources of heat or sources of ignition. Protect material from direct sunlight. Take precautionary measures against static discharge. Use only non-sparking tools. Use personal protective equipment as required. Avoid breathing mist or vapor. Avoid contact with eyes, skin, and clothing. Do not taste or swallow. Do not eat, drink or smoke when using the product. Use only with adequate ventilation. Wash hands thoroughly after handling. See Section 8 of the SDS for Personal Protective Equipment.
Conditions for safe storage, including any incompatibilities:	Keep away from food, drink and animal feeding stuffs. Keep out of reach of children. Keep container tightly closed in a cool, well-ventilated place. Store in a dry place. Ground container and transfer equipment to eliminate static electric sparks. Comply with all national, state, and local codes pertaining to the storage, handling, dispensing, and disposal of flammable liquids.

8. Exposure controls/personal protection

Control Parameters

Occupational Exposure Limits

Chemical Identity	Type	Exposure Limit Values	Source
METHYL ALCOHOL	TWA	200 ppm	US. ACGIH Threshold Limit Values (2011)
	STEL	250 ppm	US. ACGIH Threshold Limit Values (2011)
	STEL	325 mg/m3	US. NIOSH: Pocket Guide to Chemical Hazards (2010)
	REL	260 mg/m3	US. NIOSH: Pocket Guide to Chemical Hazards (2010)
	PEL	260 mg/m3	US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000) (02 2006)
	TWA	260 mg/m3	US. OSHA Table Z-1-A (29 CFR 1910.1000) (1989)
	STEL	325 mg/m3	US. OSHA Table Z-1-A (29 CFR 1910.1000) (1989)

Biological Limit Values

Chemical Identity	Exposure Limit Values	Source
METHYL ALCOHOL (methanol: Sampling time: End of shift.)	15 mg/l (Urine)	ACGIH BEL (03 2013)

Appropriate Engineering Controls No data available.

Individual protection measures, such as personal protective equipment

General information: Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level. An eye wash and safety shower must be available in the immediate work area. Use explosion-proof ventilation equipment.

Eye/face protection: Chemical goggles and face shield are recommended.

Skin Protection

Hand Protection: Chemical resistant gloves

Other: Wear suitable protective clothing and gloves.

Respiratory Protection: In case of inadequate ventilation use suitable respirator.

Hygiene measures: Provide eyewash station and safety shower. Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing to remove contaminants. Discard contaminated footwear that cannot be cleaned. Wash contaminated clothing before reuse.

9. Physical and chemical properties

Appearance

Physical state:	Liquid
Form:	Liquid
Color:	Colorless
Odor:	Characteristic, Pungent
Odor threshold:	No data available.
pH:	No data available.
Melting point/freezing point:	-97.8 °C
Initial boiling point and boiling range:	64 °C (101.3 kPa)
Flash Point:	11 - 12 °C (Closed Cup)
Evaporation rate:	No data available.
Flammability (solid, gas):	Class IB Flammable Liquid
Upper/lower limit on flammability or explosive limits	
Flammability limit - upper (%):	36 %(V)
Flammability limit - lower (%):	6 %(V)
Explosive limit - upper (%):	No data available.
Explosive limit - lower (%):	No data available.
Vapor pressure:	16.9 kPa (25 °C)
Vapor density:	1.11 AIR=1
Relative density:	0.8 (20 °C)
Solubility(ies)	
Solubility in water:	1,000 g/l Miscible with water.
Solubility (other):	No data available.
Partition coefficient (n-octanol/water):	-0.77
Auto-ignition temperature:	464 °C
Decomposition temperature:	No data available.
Viscosity:	No data available.

Other information

Molecular weight: 32.04 g/mol (CH4O)

10. Stability and reactivity

Reactivity: Contact with metals may evolve flammable hydrogen gas.

Chemical Stability: Material is stable under normal conditions.

Possibility of Hazardous Reactions: Hazardous polymerization does not occur.

Conditions to Avoid: Heat, sparks, flames. Sunlight.

Incompatible Materials: Oxidizing agents. Strong oxidizing agents. Acids.

Hazardous Decomposition Products: Thermal decomposition may release oxides of carbon. Formaldehyde. Toxic gas

11. Toxicological information

Information on likely routes of exposure

Ingestion: Toxic if swallowed.

Inhalation: Toxic by inhalation.

Skin Contact: Toxic in contact with skin.

Eye contact: Causes serious eye irritation.

Information on toxicological effects

Acute toxicity (list all possible routes of exposure)

Oral
Product: LD 50 (Rat): 5,628 mg/kg
LD 50 (Mouse): 7,300 mg/kg
LD 50 (Rabbit): 14,300 mg/kg

Dermal
Product: LD 50 (Rabbit): 15,800 mg/kg

Inhalation
Product: LC 50 (Rat, 1 h): > 145000 ppm
LC 50 (Rat, 4 h): 64000 ppm

Repeated Dose Toxicity
Product: In serious cases absorption of methanol in the body may lead to damage to the eyesight.

Skin Corrosion/Irritation
Product: Causes skin irritation.

Serious Eye Damage/Eye Irritation
Product: Causes eye irritation.

Respiratory or Skin Sensitization
Product: Not a skin sensitizer.

Carcinogenicity
Product: This substance has no evidence of carcinogenic properties.

IARC Monographs on the Evaluation of Carcinogenic Risks to Humans:
No carcinogenic components identified

US. National Toxicology Program (NTP) Report on Carcinogens:
No carcinogenic components identified

US. OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050):
No carcinogenic components identified

Germ Cell Mutagenicity

In vitro
Product: No mutagenic components identified

In vivo
Product: No mutagenic components identified

Reproductive Toxicity
Product: Suspected of damaging fertility or the unborn child.

Specific Target Organ Toxicity - Single Exposure
Product: Central nervous system. Eyes.

Specific Target Organ Toxicity - Repeated Exposure
Product: None known.

Aspiration Hazard
Product: No data available.

Other Effects: None known.

12. Ecological information

Ecotoxicity:

Acute hazards to the aquatic environment:

Fish
Product: LC 50 (Fathead minnow (Pimephales promelas), 96 h): > 100 mg/l

Aquatic Invertebrates
Product: EC 50 (Water flea (Daphnia magna), 48 h): > 10,000 mg/l

Chronic hazards to the aquatic environment:

Fish
Product: No data available.

Aquatic Invertebrates
Product: No data available.

Toxicity to Aquatic Plants
Product: No data available.

Persistence and Degradability

Biodegradation
Product: Expected to be readily biodegradable.

BOD/COD Ratio
Product: No data available.

Bioaccumulative Potential

Bioconcentration Factor (BCF)
Product: May accumulate in soil and water systems.

Partition Coefficient n-octanol / water (log Kow)
Product: Log Kow: -0.77

Mobility in Soil: No data available.

Other Adverse Effects: The product components are not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment.

13. Disposal considerations

Disposal instructions: Discharge, treatment, or disposal may be subject to national, state, or local laws.

Contaminated Packaging: Since emptied containers retain product residue, follow label warnings even after container is emptied.

14. Transport information

DOT

UN Number:	UN 1230
UN Proper Shipping Name:	Methanol
Transport Hazard Class(es)	
Class(es):	3
Label(s):	3
Packing Group:	II
Marine Pollutant:	No

IMDG

UN Number:	UN 1230
UN Proper Shipping Name:	METHANOL
Transport Hazard Class(es)	
Class(es):	3, 6.1
Label(s):	3, 6.1
EmS No.:	F-E, S-D
Packing Group:	II
Marine Pollutant:	No

IATA

UN Number:	UN 1230
Proper Shipping Name:	Methanol
Transport Hazard Class(es):	
Class(es):	3, 6.1
Label(s):	3, 6.1
Marine Pollutant:	No
Packing Group:	II

15. Regulatory information

US Federal Regulations

TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)
US. OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)
None present or none present in regulated quantities.

CERCLA Hazardous Substance List (40 CFR 302.4):
METHYL ALCOHOL Reportable quantity: 5000 lbs.

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Hazard categories

X	Acute (Immediate)	X	Chronic (Delayed)	X	Fire		Reactive		Pressure Generating

SARA 302 Extremely Hazardous Substance
None present or none present in regulated quantities.

SARA 304 Emergency Release Notification

Chemical Identity	RQ
METHYL ALCOHOL	5000 lbs.

SARA 311/312 Hazardous Chemical

Chemical Identity	Threshold Planning Quantity
METHYL ALCOHOL	500 lbs

SARA 313 (TRI Reporting)

Chemical Identity	Reporting threshold for other users	Reporting threshold for manufacturing and processing
METHYL ALCOHOL	10000 lbs	25000 lbs.

Clean Water Act Section 311 Hazardous Substances (40 CFR 117.3)
None present or none present in regulated quantities.

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130):
None present or none present in regulated quantities.

US State Regulations

US. California Proposition 65
METHYL ALCOHOL Developmental toxin. WARNING: This product contains a chemical known to the State of California to cause birth defects or other reproductive harm.

US. New Jersey Worker and Community Right-to-Know Act
METHYL ALCOHOL Listed

US. Massachusetts RTK - Substance List
METHYL ALCOHOL Listed

US. Pennsylvania RTK - Hazardous Substances
METHYL ALCOHOL Listed

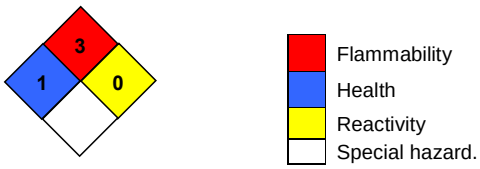
US. Rhode Island RTK
METHYL ALCOHOL Listed

Inventory Status:

Australia AICS:	On or in compliance with the inventory
Canada DSL Inventory List:	On or in compliance with the inventory
EINECS, ELINCS or NLP:	On or in compliance with the inventory
Japan (ENCS) List:	On or in compliance with the inventory
China Inv. Existing Chemical Substances:	Not in compliance with the inventory.
Korea Existing Chemicals Inv. (KECI):	On or in compliance with the inventory
Canada NDSL Inventory:	Not in compliance with the inventory.
Philippines PICCS:	On or in compliance with the inventory
US TSCA Inventory:	On or in compliance with the inventory
New Zealand Inventory of Chemicals:	On or in compliance with the inventory
Japan ISHL Listing:	On or in compliance with the inventory
Japan Pharmacopoeia Listing:	Not in compliance with the inventory.

16.Other information, including date of preparation or last revision

NFPA Hazard ID



Hazard rating: 0 - Minimal; 1 - Slight; 2 - Moderate; 3 - Serious; 4 - Severe

Issue Date:	03-05-2015
Revision Date:	No data available.
Version #:	1.2
Further Information:	No data available.

Disclaimer:

THE INFORMATION PRESENTED IN THIS MATERIAL SAFETY DATA SHEET (MSDS/SDS) WAS PREPARED BY TECHNICAL PERSONNEL BASED ON DATA THAT THEY BELIEVE IN THEIR GOOD FAITH JUDGMENT IS ACCURATE. HOWEVER, THE INFORMATION PROVIDED HEREIN IS PROVIDED “AS IS,” AND AVANTOR PERFORMANCE MATERIALS MAKES AND GIVES NO REPRESENTATIONS OR WARRANTIES WHATSOEVER, AND EXPRESSLY DISCLAIMS ALL WARRANTIES REGARDING SUCH INFORMATION AND THE PRODUCT TO WHICH IT RELATES, WHETHER EXPRESS, IMPLIED, OR STATUTORY, INCLUDING WITHOUT LIMITATION<(>,<)> WARRANTIES OF ACCURACY, COMPLETENESS, MERCHANTABILITY, NON-INFRINGEMENT, PERFORMANCE, SAFETY, SUITABILITY, STABILITY, AND FITNESS FOR A PARTICULAR PURPOSE, AND ANY WARRANTIES ARISING FROM COURSE OF DEALING, COURSE OF PERFORMANCE, OR USAGE OF TRADE. THIS MSDS/SDS IS INTENDED ONLY AS A GUIDE TO THE APPROPRIATE PRECAUTIONARY HANDLING OF THE MATERIAL BY A PROPERLY TRAINED PERSON USING THIS PRODUCT, AND IS NOT INTENDED TO BE COMPREHENSIVE AS TO THE MANNER AND CONDITIONS OF USE, HANDLING, STORAGE, OR DISPOSAL OF THE PRODUCT. INDIVIDUALS RECEIVING THIS MSDS/SDS MUST ALWAYS EXERCISE THEIR OWN INDEPENDENT JUDGMENT IN DETERMINING THE APPROPRIATENESS OF SUCH ISSUES. ACCORDINGLY, AVANTOR PERFORMANCE MATERIALS ASSUMES NO LIABILITY WHATSOEVER FOR THE USE OF OR RELIANCE UPON THIS INFORMATION. NO SUGGESTIONS FOR USE ARE INTENDED AS, AND NOTHING HEREIN SHALL BE CONSTRUED AS, A RECOMMENDATION TO INFRINGE ANY EXISTING PATENTS OR TO VIOLATE ANY FEDERAL, STATE, LOCAL, OR FOREIGN LAWS. AVANTOR PERFORMANCE MATERIALS REMINDS YOU THAT IT IS YOUR LEGAL DUTY TO MAKE ALL INFORMATION IN THIS MSDS/SDS AVAILABLE TO YOUR EMPLOYEES.

B.5 ACETONE SDS

avantor

Version: 3.4
Revision Date: 03-12-2018

SAFETY DATA SHEET

According to US Regulation 29 CFR 1910.1200 (HazCom 2012)

1. Identification

Product identifier: Acetone

Other means of identification

Synonyms: 2-Propanone, Dimethyl ketone
Product No.: 2462, 2572, 2570, 9422, 9036, 9015, 9010, 9009, 9008, 9006, 9005, 9003 9002, 2443, 2437, 2435, 2432, H580, 5975, 5965, H451, 2440, 8142, 9254 2600, 8002, 8003, 3413, 2687

Recommended restrictions

Recommended use: For Laboratory, Research or Manufacturing Use.
Restrictions on use: Not determined.

Details of the supplier of the safety data sheet

Manufacturer

Company Name:	Avantor Performance Materials, LLC.
Address:	3477 Corporate Parkway Center Valley, PA 18034
Telephone:	Customer Service: 855-282-6867
Fax:	610-573-2610
Contact Person:	Environmental Health & Safety
E-mail:	info@avantormaterials.com

Emergency telephone number:
CHEMTREC: 1-800-424-9300 within US and Canada

2. Hazard(s) identification

Hazard Classification

Physical Hazards

Flammable liquids	Category 2

Health Hazards

Serious Eye Damage/Eye Irritation	Category 2A
Specific Target Organ Toxicity - Single Exposure	Category 3[1.]
Aspiration Hazard	Category 2

Target Organs

1. Narcotic effect.

Unknown toxicity - Health

Acute toxicity, inhalation, vapor	100 %
Acute toxicity, inhalation, dust or mist	100 %

Label Elements

Hazard Symbol:

Signal Word: Danger

Hazard Statement: Highly flammable liquid and vapour.
Causes serious eye irritation.
May cause drowsiness or dizziness.
May be harmful if swallowed and enters airways.

Precautionary Statements

Prevention: Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking. Keep container tightly closed. Use explosion-proof [electrical/ventilating/lighting] equipment. Ground and bond container and receiving equipment. Use non-sparking tools. Take action to prevent static discharges. Wash thoroughly after handling. Avoid breathing dust/mist/vapors/spray. Use only outdoors or in a well-ventilated area.

Response: In case of fire: Use water spray, foam, dry powder or carbon dioxide for extinction. IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water [or shower]. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists: Get medical advice/attention. IF INHALED: Remove person to fresh air and keep comfortable for breathing. Call a POISON CENTER/doctor if you feel unwell. IF SWALLOWED: Immediately call a POISON CENTER/doctor. Do NOT induce vomiting.

Storage: Store in a well-ventilated place. Keep cool. Store locked up.

Disposal: Dispose of contents/container to an appropriate treatment and disposal facility in accordance with applicable laws and regulations, and product characteristics at time of disposal.

Hazard(s) not otherwise classified (HNOC): Static accumulating flammable liquid can become electrostatically charged even in bonded and grounded equipment. Sparks may ignite liquid and vapor. May cause flash fire or explosion.

3. Composition/information on ingredients

Substances

Chemical Identity	CAS number	Content in percent (%)*
Acetone	67-64-1	99 - 100%

* All concentrations are percent by weight unless ingredient is a gas. Gas concentrations are in percent by volume.

4. First-aid measures

General information:	Get medical advice/attention if you feel unwell. Show this safety data sheet to the doctor in attendance.
Ingestion:	Call a physician or poison control center immediately. Do NOT induce vomiting. If vomiting occurs, keep head low so that stomach content doesn't get into the lungs.
Inhalation:	Move to fresh air. Get medical attention if symptoms persist.
Skin Contact:	Immediately flush with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Get medical attention if symptoms occur. Wash contaminated clothing before reuse. Destroy or thoroughly clean contaminated shoes.
Eye contact:	Immediately flush with plenty of water for at least 15 minutes. If easy to do, remove contact lenses. Get medical attention if irritation persists after washing.

Most important symptoms/effects, acute and delayed

Symptoms:	Narcotic effect.
Hazards:	None known.

Indication of immediate medical attention and special treatment needed

Treatment:	Symptoms may be delayed. Treat symptomatically.

5. Fire-fighting measures

General Fire Hazards:	Flammable liquid and vapor.

Suitable (and unsuitable) extinguishing media

Suitable extinguishing media:	Water spray, foam, dry powder or carbon dioxide.
Unsuitable extinguishing media:	Avoid water in straight hose stream; will scatter and spread fire.
Specific hazards arising from the chemical:	Vapors may cause a flash fire or ignite explosively. Vapors may travel considerable distance to a source of ignition and flash back. Prevent buildup of vapors or gases to explosive concentrations. Heat may cause the containers to explode.

Special protective equipment and precautions for firefighters

Special fire fighting procedures:	Use water spray to keep fire-exposed containers cool. Water may be ineffective in fighting the fire. Fight fire from a protected location. Move containers from fire area if you can do so without risk.
Special protective equipment for fire-fighters:	Firefighters must use standard protective equipment including flame retardant coat, helmet with face shield, gloves, rubber boots, and in enclosed spaces, SCBA.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures:	See Section 8 of the SDS for Personal Protective Equipment. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Keep unauthorized personnel away. Ventilate closed spaces before entering them. ELIMINATE all ignition sources (no smoking, flares, sparks or flames in immediate area). Keep upwind.
Methods and material for containment and cleaning up:	In case of leakage, eliminate all ignition sources. Take precautionary measures against static discharges. Stop leak if possible without any risk. Use non-sparking tools. Absorb spill with vermiculite or other inert material, then place in a container for chemical waste. Clean surface thoroughly to remove residual contamination. Dike far ahead of larger spill for later recovery and disposal.
Notification Procedures:	Inform authorities if large amounts are involved.
Environmental Precautions:	Do not contaminate water sources or sewer. Prevent further leakage or spillage if safe to do so.

7. Handling and storage

Precautions for safe handling:	DO NOT handle, store or open near an open flame, sources of heat or sources of ignition. Protect material from direct sunlight. Take precautionary measures against static discharges. Ground and bond container and receiving equipment. Use personal protective equipment as required. Do not get in eyes, on skin, on clothing. Use only with adequate ventilation. Wash hands thoroughly after handling. Do not handle until all safety precautions have been read and understood. Obtain special instructions before use.
Conditions for safe storage, including any incompatibilities:	Keep away from food, drink and animal feeding stuffs. Keep container tightly closed in a cool, well-ventilated place. Ground container and transfer equipment to eliminate static electric sparks. Comply with all national, state, and local codes pertaining to the storage, handling, dispensing, and disposal of flammable liquids.

8. Exposure controls/personal protection

Control Parameters

Occupational Exposure Limits

Chemical Identity	Type	Exposure Limit Values	Source
Acetone	TWA	250 ppm	US. ACGIH Threshold Limit Values (03 2015)
	STEL	500 ppm	US. ACGIH Threshold Limit Values (03 2015)
	REL	250 ppm 590 mg/m3	US. NIOSH: Pocket Guide to Chemical Hazards (2010)
	PEL	1,000 ppm 2,400 mg/m3	US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000) (02 2006)
	TWA	750 ppm 1,800 mg/m3	US. OSHA Table Z-1-A (29 CFR 1910.1000) (1989)
	STEL	1,000 ppm 2,400 mg/m3	US. OSHA Table Z-1-A (29 CFR 1910.1000) (1989)
	TWA	750 ppm 1,800 mg/m3	US. Tennessee. OELs. Occupational Exposure Limits, Table Z1A (06 2008)
	STEL	1,000 ppm 2,400 mg/m3	US. Tennessee. OELs. Occupational Exposure Limits, Table Z1A (06 2008)
	ST ESL	7,800 µg/m3	US. Texas. Effects Screening Levels (Texas Commission on Environmental Quality) (03 2014)
	AN ESL	4,800 µg/m3	US. Texas. Effects Screening Levels (Texas Commission on Environmental Quality) (03 2014)
	ST ESL	3,300 ppb	US. Texas. Effects Screening Levels (Texas

			Commission on Environmental Quality) (03 2014)
	AN ESL	2,000 ppb	US. Texas. Effects Screening Levels (Texas Commission on Environmental Quality) (03 2014)
	Ceiling	3,000 ppm	US. California Code of Regulations, Title 8, Section 5155. Airborne Contaminants (08 2010)
	STEL	750 ppm 1,780 mg/m3	US. California Code of Regulations, Title 8, Section 5155. Airborne Contaminants (08 2010)
	TWA PEL	500 ppm 1,200 mg/m3	US. California Code of Regulations, Title 8, Section 5155. Airborne Contaminants (08 2010)

Biological Limit Values

Chemical Identity	Exposure Limit Values	Source
Acetone (acetone: Sampling time: End of shift.)	25 mg/l (Urine)	ACGIH BEI (03 2015)

Appropriate Engineering Controls No data available.

Individual protection measures, such as personal protective equipment

General information: Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level. An eye wash and safety shower must be available in the immediate work area. Use explosion-proof ventilation equipment.

Eye/face protection: Wear safety glasses with side shields (or goggles) and a face shield.

Skin Protection
Hand Protection: Chemical resistant gloves

Other: Wear suitable protective clothing and gloves.

Respiratory Protection: In case of inadequate ventilation use suitable respirator. Chemical respirator with organic vapor cartridge.

Hygiene measures: Provide eyewash station and safety shower. Observe good industrial hygiene practices. Do not eat, drink or smoke when using the product. Wash hands before breaks and immediately after handling the product. Wash contaminated clothing before reuse. Do not get this material in contact with skin. Avoid contact with eyes. Do not handle until all safety precautions have been read and understood. Obtain special instructions before use.

9. Physical and chemical properties

Appearance

Physical state: Liquid
Form: Liquid
Color: Colorless
Odor: Sweet, mint-like
Odor threshold: No data available.
pH: 5 - 6 (20 °C)

Melting point/freezing point:	-94.8 - 94.6 °C
Initial boiling point and boiling range:	56 °C (101.3 kPa)
Flash Point:	-20 - -17 °C (Closed Cup)
Evaporation rate:	No data available.
Flammability (solid, gas):	Class IB Flammable Liquid
Upper/lower limit on flammability or explosive limits	
Flammability limit - upper (%):	12.8 %(V)
Flammability limit - lower (%):	2.13 - 2.6 %(V)
Explosive limit - upper (%):	No data available.
Explosive limit - lower (%):	No data available.
Vapor pressure:	30.9 kPa (25 °C) 233 - 240 hPa (20 °C) 530 - 560 hPa (40 °C)
Vapor density:	2
Density:	0.79 g/ml (20 °C)
Relative density:	0.80 (20 °C)
Solubility(ies)	
Solubility in water:	Miscible
Solubility (other):	Alcohol: Miscible benzene: Soluble chloroform: Miscible dimethylformamide: Miscible ether: Miscible
Partition coefficient (n-octanol/water):	-0.24
Auto-ignition temperature:	465 °C
Decomposition temperature:	No data available.
Viscosity:	No data available.
Other information	
Liquid conductivity:	0.6 µS/cm (25 °C)
Minimum ignition energy:	1.15 mJ
Molecular weight:	58.08 g/mol (C3H6O)

10. Stability and reactivity

Reactivity:	No dangerous reaction known under conditions of normal use.
Chemical Stability:	Material is stable under normal conditions.
Possibility of hazardous reactions:	Hazardous polymerization does not occur.
Conditions to avoid:	Heat, sparks, flames.
Incompatible Materials:	Oxidizers, acids
Hazardous Decomposition Products:	Thermal decomposition or combustion may liberate carbon oxides and other toxic gases or vapors.

11. Toxicological information

Information on likely routes of exposure

Inhalation:	May cause irritation to the respiratory system.

Skin Contact: May cause irritation. Prolonged or repeated skin contact may cause drying, cracking, or irritation.

Eye contact: Causes eye irritation.

Ingestion: May cause irritation of the gastrointestinal tract.

Information on toxicological effects

Acute toxicity (list all possible routes of exposure)

Oral
Product: LD 50 (Rat): 5,800 mg/kg

Dermal
Product: LD 50 (Rabbit) 20,000 mg/kg

Inhalation
Product: LC 50 (Rat, 4 h) 50.1 - 76 mg/l

Repeated dose toxicity
Product: No data available.

Skin Corrosion/Irritation
Product: Prolonged or repeated contact may cause irritation.

Serious Eye Damage/Eye Irritation
Product: Irritating to eyes.

Respiratory or Skin Sensitization
Product: Not a skin sensitizer.

Carcinogenicity
Product: This substance has no evidence of carcinogenic properties.

IARC Monographs on the Evaluation of Carcinogenic Risks to Humans:
No carcinogenic components identified

US. National Toxicology Program (NTP) Report on Carcinogens:
No carcinogenic components identified

US. OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050):
No carcinogenic components identified

Germ Cell Mutagenicity

In vitro
Product: No mutagenic components identified

In vivo
Product: No mutagenic components identified

Reproductive toxicity
Product: No components toxic to reproduction

Specific Target Organ Toxicity - Single Exposure
Product: Narcotic effect.

Specific Target Organ Toxicity - Repeated Exposure
Product: None known.

Target Organs
Specific Target Organ Toxicity - Single Exposure: Narcotic effect.

Aspiration Hazard
Product: May be harmful if swallowed and enters airways.

Other effects: None known.

12. Ecological information

Ecotoxicity:

Acute hazards to the aquatic environment:

Fish
Product: LC 50 (Fathead minnow (Pimephales promelas), 96 h): 5,490 - 7,030 mg/l Mortality
LC 50 (Bluegill (Lepomis macrochirus), 96 h): 8,300 mg/l Mortality

Aquatic Invertebrates
Product: LC 50 (Brine shrimp (Artemia salina), 24 h): 2,100 mg/l Mortality
LC 50 (Water flea (Daphnia magna), 48 h): 12,100 mg/l Mortality

Chronic hazards to the aquatic environment:

Fish
Product: No data available.

Aquatic Invertebrates
Product: No data available.

Toxicity to Aquatic Plants
Product: No data available.

Persistence and Degradability

Biodegradation
Product: Expected to be readily biodegradable.

BOD/COD Ratio
Product: No data available.

Bioaccumulative potential
Bioconcentration Factor (BCF)
Product: No data available on bioaccumulation.

Partition Coefficient n-octanol / water (log Kow)
Product: Log Kow: -0.24

Mobility in soil: No data available.

Other adverse effects: The product components are not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment.

13. Disposal considerations

Disposal instructions: Discharge, treatment, or disposal may be subject to national, state, or local laws.

Contaminated Packaging: Since emptied containers retain product residue, follow label warnings even after container is emptied.

14. Transport information

DOT

UN Number:	UN 1090
UN Proper Shipping Name:	Acetone
Transport Hazard Class(es)	
Class:	3
Label(s):	3
Packing Group:	II
Marine Pollutant:	No
Special precautions for user:	Not determined.

IMDG

UN Number:	UN 1090
UN Proper Shipping Name:	ACETONE
Transport Hazard Class(es)	
Class:	3
Label(s):	3
EmS No.:	F-E, S-D
Packing Group:	II
Marine Pollutant:	No
Special precautions for user:	Not determined.

IATA

UN Number:	UN 1090
Proper Shipping Name:	Acetone
Transport Hazard Class(es):	
Class:	3
Label(s):	3
Packing Group:	II
Marine Pollutant:	No
Special precautions for user:	Not determined.

15. Regulatory information

US Federal Regulations

TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)

None present or none present in regulated quantities.

US. OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

None present or none present in regulated quantities.

CERCLA Hazardous Substance List (40 CFR 302.4):

Chemical Identity	Reportable quantity
Acetone	5000 lbs.

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Hazard categories

Flammable liquids
Serious Eye Damage/Eye Irritation
Specific Target Organ Toxicity - Single Exposure
Static-accumulating flammable liquid

SARA 302 Extremely Hazardous Substance

None present or none present in regulated quantities.

SARA 304 Emergency Release Notification

Chemical Identity	Reportable quantity
Acetone	5000 lbs.

SARA 311/312 Hazardous Chemical

Chemical Identity	Threshold Planning Quantity
Acetone	10000 lbs.

SARA 313 (TRI Reporting)

None present or none present in regulated quantities.

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130):

None present or none present in regulated quantities.

Clean Water Act Section 311 Hazardous Substances (40 CFR 117.3):

None present or none present in regulated quantities.

US State Regulations

US. California Proposition 65

No ingredient regulated by CA Prop 65 present.

US. New Jersey Worker and Community Right-to-Know Act

Chemical Identity
Acetone

US. Massachusetts RTK - Substance List

Chemical Identity
Acetone

US. Pennsylvania RTK - Hazardous Substances

Chemical Identity
Acetone

US. Rhode Island RTK

Chemical Identity
Acetone

International regulations

Montreal protocol

not applicable

Stockholm convention
not applicable

Rotterdam convention
not applicable

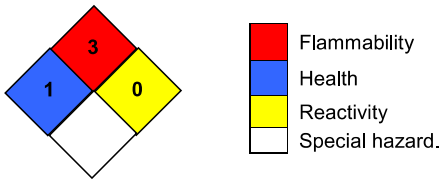
Kyoto protocol
not applicable

Inventory Status:

Australia AICS:	On or in compliance with the inventory
Canada DSL Inventory List:	On or in compliance with the inventory
EINECS, ELINCS or NLP:	On or in compliance with the inventory
Japan (ENCS) List:	On or in compliance with the inventory
China Inv. Existing Chemical Substances:	On or in compliance with the inventory
Korea Existing Chemicals Inv. (KECI):	On or in compliance with the inventory
Philippines PICCS:	On or in compliance with the inventory
US TSCA Inventory:	On or in compliance with the inventory
New Zealand Inventory of Chemicals:	On or in compliance with the inventory
Mexico INSQ:	On or in compliance with the inventory
Taiwan Chemical Substance Inventory:	On or in compliance with the inventory

16.Other information, including date of preparation or last revision

NFPA Hazard ID



Hazard rating: 0 - Minimal; 1 - Slight; 2 - Moderate; 3 - Serious; 4 - Severe; RNP - Rating not possible

Issue Date:	03-12-2018
Revision Information:	Not relevant.
Version #:	3.4
Source of information:	Sources of information used in preparing this SDS included one or more of the following: results from in house or supplier toxicology studies, information from the Toxicology Data Network (TOXNET), European Chemical Agency (ECHA) substance dossiers, IARC Monographs, US National Toxicology Program data, the Agency for Toxic Substances and Disease Registry, other manufacturer's SDSs and other sources, as appropriate.
Further Information:	No data available.

avantor

Version: 3.4
Revision Date: 03-12-2018

Disclaimer:

The information provided in this Safety Data Sheet (SDS) was prepared based on data believed to be accurate as of the date of this SDS. TO THE GREATEST EXTENT PERMITTED BY LAW, AVANTOR PERFORMANCE MATERIALS ("AVANTOR") EXPRESSLY DISCLAIMS ANY AND ALL REPRESENTATIONS AND WARRANTIES REGARDING THE INFORMATION CONTAINED HEREIN INCLUDING, WITHOUT LIMITATION, AS TO ACCURACY, COMPLETENESS, FITNESS FOR PURPOSE OR USE, MERCHANTABILITY, NON-INFRINGEMENT, PERFORMANCE, SAFETY, SUITABILITY AND STABILITY. This SDS is intended as a guide to the appropriate use, handling, storage and disposal of the product to which it relates by properly trained personnel, and is not intended to be comprehensive. Users of Avantor's products are advised to perform their own tests and to exercise their own judgment to determine the safety, suitability and appropriate use, handling, storage and disposal of each product and product combination for their own purposes and uses. TO THE GREATEST EXTENT PERMITTED BY LAW, AVANTOR DISCLAIMS LIABILITY FOR, AND BY USING AVANTOR'S PRODUCTS PURCHASER AGREES THAT UNDER NO CIRCUMSTANCES SHALL AVANTOR BE LIABLE FOR, SPECIAL, INDIRECT, INCIDENTAL , PUNITIVE OR CONSEQUENTIAL DAMAGES OF ANY TYPE OR KIND, INCLUDING WITHOUT LIMITATION, FOR LOSS OF PROFITS, REPUTATIONAL DAMAGE, PRODUCT RECALL OR BUSINESS INTERRUPTION.

B.6 FORMULA 409 SDS

THE CLOROX COMPANY

SAFETY DATA SHEET

Issuing Date January 5, 2015 **Revision Date** New **Revision Number** 0

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

Product identifier

Product Name **Formula 409® Antibacterial All-Purpose Cleaner**

Other means of identification

EPA Registration Number 5813-73

Recommended use of the chemical and restrictions on use

Recommended Use Multi-purpose spray cleaner and disinfectant

Uses advised against No information available

Details of the supplier of the safety data sheet

Supplier Address
The Clorox Company
1221 Broadway
Oakland, CA 94612

Phone: 1-510-271-7000

Emergency telephone number

Emergency Phone Numbers For Medical Emergencies call: 1-800-446-1014
For Transportation Emergencies, call Chemtrec: 1-800-424-9300

2. HAZARDS IDENTIFICATION

Classification

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

Skin corrosion/irritation	Category 3

GHS Label elements, including precautionary statements

Emergency Overview

Signal word **Warning**

Hazard statements
Causes mild skin irritation

No pictogram required.

Appearance Clear, green **Physical State** Thin liquid **Odor** Floral, citrus

Precautionary Statements - Prevention
None

Precautionary Statements - Response
If skin irritation occurs: Get medical advice.

Precautionary Statements - Storage
None

Precautionary Statements - Disposal
None

Hazards not otherwise classified (HNOC)
Not applicable

Unknown Toxicity
0.2% of the mixture consists of ingredient(s) of unknown toxicity

Other information
Very toxic to aquatic life with long-lasting effects.

Interactions with Other Chemicals
None known.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Chemical Name	CAS-No	Weight %	Trade Secret
Lauramine oxide	1643-20-5	0.5 - 1.5	*
n-Alkyl (40% C12, 50% C14, 10% C16) dimethyl benzyl ammonium chloride	68424-85-1	0.2 - 0.4	*

* The exact percentage (concentration) of composition has been withheld as a trade secret

4. FIRST AID MEASURES

First aid measures

General Advice	Show this safety data sheet to the doctor in attendance.
Eye Contact	Hold eye open and rinse slowly and gently with water for 15 - 20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.
Skin Contact	Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.
Inhalation	Move to fresh air. If breathing is affected, call a doctor.
Ingestion	Call a poison control center or doctor immediately for treatment advice. Have person sip a glassful of water if able to swallow. DO NOT induce vomiting unless told to do so by a poison control center or doctor. Do not give anything by mouth to an unconscious person.

Most important symptoms and effects, both acute and delayed

Most Important Symptoms/Effects Mild irritation of eyes and skin.

Indication of any immediate medical attention and special treatment needed

Notes to Physician Treat symptomatically.

5. FIRE-FIGHTING MEASURES

Suitable Extinguishing Media
Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Unsuitable Extinguishing Media
CAUTION: Use of water spray when fighting fire may be inefficient.

Specific Hazards Arising from the Chemical
No information available

Explosion Data

Sensitivity to Mechanical Impact None

Sensitivity to Static Discharge None

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.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Personal Precautions Avoid contact with eyes and skin.

Other Information Refer to protective measures listed in Sections 7 and 8.

Environmental precautions

Environmental Precautions See Section 12 for additional ecological Information

Methods and material for containment and cleaning up

Methods for Containment Prevent further leakage or spillage if safe to do so.

Methods for Cleaning Up Absorb and containerize. Wash residual down to sanitary sewer. Contact the sanitary treatment facility in advance to assure ability to process washed-down material.

7. HANDLING AND STORAGE

Precautions for safe handling

Handling Handle in accordance with good industrial hygiene and safety practice. Avoid contact with eyes, skin, and clothing. Do not eat, drink, or smoke when using this product.

Conditions for safe storage, including any incompatibilities

Storage Keep containers tightly closed in a dry, cool, and well-ventilated place.

Incompatible Products None known.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control parameters

Exposure Guidelines

Chemical Name	ACGIH TLV	OSHA PEL	NIOSH IDLH
Lauramine oxide 1643-20-5	None	None	None
n-Alkyl (40% C12, 50% C14, 10% C16) dimethyl benzyl ammonium chloride 68424-85-1	None	None	None

ACGIH TLV: American Conference of Governmental Industrial Hygienists - Threshold Limit Value. OSHA PEL: Occupational Safety and Health Administration - Permissible Exposure Limits. NIOSH IDLH: Immediately Dangerous to Life or Health.

Appropriate engineering controls

Engineering Measures Showers
Eyewash stations
Ventilation systems

Individual protection measures, such as personal protective equipment

Eye/Face Protection	If splashes are likely to occur, wear safety glasses with side-shields. None required for consumer use.
Skin and Body Protection	No special protective equipment required.
Respiratory Protection	If irritation is experienced, NIOSH/MSHA approved respiratory protection should be worn. Positive-pressure supplied air respirators may be required for high airborne contaminant concentrations. Respiratory protection must be provided in accordance with current local regulations.
Hygiene Measures	Remove and wash contaminated clothing before re-use. Avoid contact with skin, eyes, or clothing. Do not eat, drink, or smoke when using this product.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical and Chemical Properties

Physical State	Thin liquid		
Appearance	Clear	**Odor**	Floral, citrus
Color	Green	**Odor Threshold**	No information available

Property	**Values**	**Remarks/ Method**
pH	9 - 11.5	None known
Melting/freezing point	No data available	None known
Boiling Point/Range	No data available	None known
Flash Point	No data available	None known
Evaporation rate	No data available	None known
Flammability (solid, gas)	No data available	None known
Flammability Limits in Air		
Upper flammability limit	No data available	None known
Lower flammability limit	No data available	None known
Vapor pressure	No data available	None known
Vapor density	No data available	None known
Specific Gravity	~1.0	None known
Water Solubility	Soluble in water.	None known
Solubility in other solvents	No data available	None known
Partition coefficient: n-octanol/water	No data available	None known
Autoignition temperature	No data available	None known
Decomposition temperature	No data available	None known
Kinematic viscosity	No data available	None known
Dynamic viscosity	No data available	None known
Explosive Properties	Not explosive	
Oxidizing Properties	No data available	

Other Information

Softening Point	No data available
VOC Content (%)	No data available
Particle Size	No data available
Particle Size Distribution	No data available

10. STABILITY AND REACTIVITY

Reactivity
No data available.

Chemical stability
Stable under recommended storage conditions.

Possibility of Hazardous Reactions
None under normal processing.

Conditions to avoid
None known.

Incompatible materials
None known.

Hazardous Decomposition Products
None known based on information supplied.

11. TOXICOLOGICAL INFORMATION

Information on likely routes of exposure

Product Information

Inhalation	Exposure to vapor or mist may irritate respiratory tract.
Eye Contact	May cause eye irritation.
Skin Contact	Prolonged contact may cause irritation.
Ingestion	Ingestion may cause irritation to mucous membranes and gastrointestinal irritation, nausea, vomiting, and diarrhea.

Information on toxicological effects

Symptoms May cause redness and tearing of the eyes and skin redness.

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

Sensitization	No information available.
Mutagenic Effects	No information available.
Carcinogenicity	Contains no ingredient listed as a carcinogen.
Reproductive Toxicity	No information available
STOT - single exposure	No information available.
STOT - repeated exposure	No information available.
Chronic Toxicity	No known effect.
Target Organ Effects	Respiratory system, eyes, skin, gastrointestinal tract (GI).
Aspiration Hazard	No information available.

Numerical measures of toxicity Product Information

The following values are calculated based on chapter 3.1 of the GHS document Not applicable.

12. ECOLOGICAL INFORMATION

Ecotoxicity
Very toxic to aquatic life with long lasting effects.

Persistence and Degradability
No information available.

Bioaccumulation
No information available.

Other Adverse Effects
No information available.

13. DISPOSAL CONSIDERATIONS

Disposal methods
Dispose of in accordance with all applicable federal, state, and local regulations.

Contaminated Packaging
Do not reuse empty containers. Dispose of in accordance with all applicable federal, state, and local regulations.

14. TRANSPORT INFORMATION

DOT	Not regulated
TDG	Not regulated
ICAO	Not regulated
IATA	Not regulated
IMDG/IMO	Not regulated

15. REGULATORY INFORMATION

Chemical Inventories

TSCA	All components of this product are either on the TSCA 8(b) Inventory or otherwise exempt from listing.
DSL/NDSL	All components are on the DSL or NDSL.

TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List

U.S. Federal Regulations

SARA 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	No
Sudden Release of Pressure Hazard	No
Reactive Hazard	No

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).

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.

EPA Statement
This chemical is a pesticide product registered by the Environmental Protection Agency and is subject to certain labeling requirements under federal pesticide law. These requirements differ from the classification criteria and hazard information required for safety data sheets and for workplace labels of non-pesticide chemicals. Following is the hazard information as required on the pesticide label:

> **CAUTION:** Causes moderate eye irritation. Avoid contact with eyes, skin or clothing. Wash thoroughly with soap and water after handling. Avoid contact with foods.

U.S. State Regulations

California Proposition 65
This product does not contain any Proposition 65 chemicals.

U.S. State Right-to-Know Regulations

Chemical Name	New Jersey	Massachusetts	Pennsylvania	Rhode Island	Illinois
Ethanolamine 141-43-5	X	X	X	-	X

International Regulations

Canada
WHMIS Hazard Class
D2B Toxic Materials

16. OTHER INFORMATION

NFPA	**Health Hazard** 1	**Flammability** 0	**Instability** 0	**Physical and Chemical Hazards** -
HMIS	**Health Hazard** 1	**Flammability** 0	**Physical Hazard** 0	**Personal Protection** B

Prepared By
Product Stewardship
23 British American Blvd.
Latham, NY 12110
1-800-572-6501

Preparation/Revision Date January 5, 2015

Revision Date New

Revision Note New

Reference 1071534/166962.001

General Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information, and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text

End of Safety Data Sheet

B.7 WINDEX SDS

Material Safety Data Sheet

WINDEX GLASS CLEANER (RTU)

National Fire Protection Association (NFPA)		Hazardous Material Information System (HMIS)	
	Fire Hazard: 1	Health	0
Health: 0	Reactivity: 0	Fire Hazard	1
	Specific Hazard	Reactivity	0

Protective Clothing None required.

Emergency Overview Clear Blue. Liquid. See Section 9.

Section 1. Chemical Product and Company Identification

Product Name	**WINDEX GLASS CLEANER (RTU)**	**Code**	90122 & 90135 & 90139 & 90940 & 94099
Product Use	Industrial/Institutional: Cleaning product.	**PMS#**	455934
MSDS#	126011002	**Validation Date**	4/8/2003
U.S. Headquarters Drackett Professional A Division of S.C. Johnson Commercial Markets, Inc. 8310 16th Street Sturtevant, Wisconsin 53177-0902 Phone: (888) 352-2249		**Print Date**	4/8/2003
		Supersedes	10/21/2002.
		In Case of Emergency	(800) 851-7145

Section 2. Composition and Information on Ingredients

Ingredients	CAS #	% by Weight	Exposure Limits	LC50/LD50
2-Butoxyethanol	111-76-2	0.5-1.5	**OSHA (United States).** TWA: 120 mg/m³ **ACGIH (United States).** TWA: 97 mg/m³	ORAL (LD50): Acute: 506 mg/kg [Rat]. DERMAL (LD50): Acute: 406 mg/kg [Rabbit]. VAPOR (LC50): Acute: 450 ppm 4 hour(s) [Rat].
Ethylene glycol hexyl ether	112-25-4	0.5-1.5	Not available.	Not available.
Isopropyl Alcohol	67-63-0	1-5	**OSHA (United States).** TWA: 980 mg/m³ STEL: 1225 mg/m³ **ACGIH (United States).** TWA: 983 mg/m³ STEL: 1230 mg/m³	ORAL (LD50): Acute: 5045 mg/kg [Rat]. DERMAL (LD50): Acute: 12800 mg/kg [Rabbit]. VAPOR (LC50): Acute: 16000 ppm 8 hour(s) [Rat].
Water	7732-18-5	60-100	Not available.	Not available.

Section 3. Hazards Identification

Routes of Entry Inhalation. Skin contact. Eye contact.

Potential Acute Health Effects

Eyes None known.

Skin None known.

Inhalation None known.

Ingestion None known.

Medical Conditions Aggravated by Overexposure: None known.

See Toxicological Information (section 11)

Continued on Next Page

WINDEX GLASS CLEANER (RTU)

Section 4. First Aid Measures

Eye Contact	Rinse with plenty of running water.
Skin Contact	Rinse with plenty of running water.
Inhalation	No specific first aid measures are required.
Ingestion	No specific first aid measures are required.

Section 5. Fire Fighting Measures

Flammability of the Product	Although this product has a flash point below 200 Deg. F, it is an aqueous solution containing an alcohol and does not sustain combustion.
Flash Points	Closed cup: 51.1°C (124°F).
Products of Combustion	None known.
Fire Fighting Media and Instructions	Extinguish with water spray or carbon dioxide, dry chemical powder or appropriate foam. Normal fire fighting procedure may be used.
Special Remarks on Fire and Explosion Hazards	None known.

Section 6. Accidental Release Measures

Personal Precautions	Put on appropriate personal protective equipment (see Section 8.).
Environmental Precautions and Clean-up Methods	In the event of major spillage: Use appropriate containment to avoid environmental contamination. Sweep or scrape up material. Place in suitable clean, dry containers for disposal by approved methods. Use a water rinse for final clean-up.

Section 7. Handling and Storage

Handling	Avoid contact with eyes. Use appropriate hygiene measures when handling product. FOR INDUSTRIAL USE ONLY
Storage	Store in a dry, cool and well-ventilated area. Protect from freezing. KEEP OUT OF REACH OF CHILDREN.

Section 8. Exposure Controls/Personal Protection

Engineering Controls	No special ventilation requirements. General room ventilation is adequate.
Personal Protection	
Eyes	No special requirements under normal use conditions.
Hands	No special requirements under normal use conditions.
Respiratory	No special requirements under normal use conditions.
Feet	No special requirements under normal use conditions.
Body	No special protective clothing is required.

Section 9. Physical and Chemical Properties

Physical State and Appearance	Liquid.
Odor	Mild. Ammoniacal.
Color	Clear Blue.
pH	10.6 to 11.5 [Basic.]
Specific Gravity	1
Solubility in water	Complete.

Continued on Next Page

WINDEX GLASS CLEANER (RTU)

Section 10. Stability and Reactivity

Stability and Reactivity	The product is stable.
Conditions of Instability	None known.
Incompatibility with Various Substances	Not available.
Hazardous Decomposition Products	When exposed to fire: Produces normal products of combustion.
Hazardous Polymerization	Will not occur.

Section 11. Toxicological Information

Acute toxicity	ORAL (LD50) Estimated to be greater than 5000 mg/kg (rat).
Effects of Chronic Exposure	None known.
Other Toxic Effects	Not available.

Section 12. Ecological Information

Not available.

Section 13. Disposal Considerations

Waste Information	No special precautions. Dispose of according to all federal, state and local regulations.

Section 14. Transport Information

DOT Classification

DOT Proper Shipping Name	- Please refer to the Bill of Lading/receiving documents for up to date shipping information.

TDG Classification

TDG Proper Shipping Name	- Please refer to the Bill of Lading/receiving documents for up to date shipping information.

Section 15. Regulatory Information

Reporting in this section is based on ingredients disclosed in Section 2

US Regulations

Federal	SARA 313 toxic chemical notification and release reporting: Isopropyl Alcohol CERCLA: Hazardous substances.: Isopropyl Alcohol
State	New Jersey spill list: Isopropyl Alcohol New Jersey: Isopropyl Alcohol Massachusetts spill list: Isopropyl Alcohol Massachusetts RTK: Isopropyl Alcohol Pennsylvania RTK: Isopropyl Alcohol This product is not subject to the reporting requirements under California's Proposition 65.
Registered Product Information	Not applicable.

Canadian Regulations

WHMIS Classification	Not controlled under WHMIS (Canada).
WHMIS Icon	
Registered Product Information	Not applicable.

Chemical Inventory Status	All ingredients of this product are listed or are excluded from listing on the U.S. Toxic Substances Control Act (TSCA) Chemical Substance Inventory

Continued on Next Page

Material Safety Data Sheet

WINDEX GLASS CLEANER (RTU)

Section 16. Other Information	
Other Special Considerations	MSDS Serial Range: 2-3
Version	2.1

Notice to Reader

This document has been prepared using data from sources considered technically reliable. It does not constitute a warranty, express or implied, as to the accuracy of the information contained within. Actual conditions of use and handling are beyond seller's control. User is responsible to evaluate all available information when using product for any particular use and to comply with all Federal, State, Provincial and Local laws and regulations.

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX Z: RECORD OF ACCEPTANCE

Z.1 STATEMENT OF ACCEPTANCE

By signing the record sheet below corresponding to the year of acceptance, I certify that I have reviewed this document with all relevant stakeholders and that it meets HYPER Lab standards of Safety and Professionalism. To the best of my knowledge, this document is an accurate representation of the system as it currently exists and the procedures in place to ensure the system is operated safely. This system and these procedures have been developed to the best of the HYPER Lab's ability to meet all applicable codes in the Code of Federal Regulations, the Washington Administrative Codes, and WSU Policies and Procedures; as well as industry standards and best practices. As Lab Director, or other such authority as having been designated by the Lab Director, I accept this document to be up to date and meeting all requirements of the HYPER Lab.

Z.2 RECORD

Signed as of the date listed below the signature line.

X

Date: / /2019. Reviewed and accepted in 2019.

X

Date: / /2020. Reviewed and accepted in 2020.

X

Date: / /2021. Reviewed and accepted in 2021.

X

Date: / /2022. Reviewed and accepted in 2022.