



CAMEO Chemicals

Substances In This Report

- 1. HYDROGEN
- 2. METHANOL
- 3. CARBON DIOXIDE
- 4. CARBON MONOXIDE
- 5. WATER

Contents

This report contains:

- Reaction hazard predictions associated with mixing these substances.
- Detailed information from the datasheet for each substance.

Chemical Reactivity

Substances In The Mix

- 1. HYDROGEN
- 2. METHANOL
- 3. CARBON DIOXIDE
- 4. CARBON MONOXIDE
- 5. WATER

Summary of Hazard Predictions (for all pairs of substances)

- Corrosive: Reaction products may be corrosive
- Flammable: Reaction products may be flammable
- Generates gas: Reaction liberates gaseous products and may cause pressurization
- Generates heat: Exothermic reaction at ambient temperatures (releases heat)
- Potentially hazardous: May be hazardous but unknown

Summary of Gas Predictions (for all pairs of substances)

May produce the following gases:

• Hydrogen (H2)

🔔 Reactivity Alerts

HYDROGEN

• Highly Flammable

METHANOL

• Highly Flammable

CARBON MONOXIDE

• Highly Flammable

Hazard Predictions (for each pair of substances)

METHANOL *mixed with* HYDROGEN

- Flammable: Reaction products may be flammable
- Generates gas: Reaction liberates gaseous products and may cause pressurization
- Potentially hazardous: May be hazardous but unknown
- May produce the following gases:
 - Hydrogen

CARBON DIOXIDE *mixed with* HYDROGEN

• No known hazardous reaction

CARBON DIOXIDE *mixed with* METHANOL

• No known hazardous reaction

CARBON MONOXIDE *mixed with* HYDROGEN

• No known hazardous reaction

CARBON MONOXIDE *mixed with* METHANOL

- Flammable: Reaction products may be flammable
- Generates gas: Reaction liberates gaseous products and may cause pressurization
- Potentially hazardous: May be hazardous but unknown
- May produce the following gases:
 - Hydrogen

CARBON MONOXIDE *mixed with* CARBON DIOXIDE

• No known hazardous reaction

WATER *mixed with* HYDROGEN

• No known hazardous reaction

WATER *mixed with* METHANOL

• No known hazardous reaction

WATER *mixed with* CARBON DIOXIDE

- Corrosive: Reaction products may be corrosive
- Generates heat: Exothermic reaction at ambient temperatures (releases heat)

WATER *mixed with* CARBON MONOXIDE

• No known hazardous reaction

HYDROGEN



Chemical Identifiers

CAS Number	UN/NA Number	DOT Hazard Label	USCG CHRIS Code
1333-74-0 🔎	1049	Flammable Gas	HXX
NIOSH Pocket Gui	de	International Chem Safe	ty Card

HYDROGEN

none

NFPA 704

Diamond	Hazard	Value	Description
$4 \qquad \qquad $			No hazard beyond that of ordinary combustible material.
0 0	Flammability	4	Burns readily. Rapidly or completely vaporizes at atmospheric pressure and normal ambient temperature.
Instability 0		0	Normally stable, even under fire conditions.
	Special		

(NFPA, 2010)

General Description

Hydrogen is a colorless, odorless gas. It is easily ignited. Once ignited it burns with a pale blue, almost invisible flame. The vapors are lighter than air. It is flammable over a wide range of vapor/air concentrations. Hydrogen is not toxic but is a simple asphyxiate by the displacement of oxygen in the air. Under prolonged exposure to fire or intense heat the containers may rupture violently and rocket. Hydrogen is used to make other chemicals and in oxyhydrogen welding and cutting.

Hazards

Reactivity Alerts

Highly Flammable

Air & Water Reactions

Highly flammable.

Fire Hazard

Excerpt from ERG Guide 115 [Gases - Flammable (Including Refrigerated Liquids)]:

EXTREMELY FLAMMABLE. Will be easily ignited by heat, sparks or flames. Will form explosive mixtures with air. Vapors from liquefied gas are initially heavier than air and spread along ground. CAUTION: Hydrogen (UN1049),

Deuterium (UN1957), Hydrogen, refrigerated liquid (UN1966), Methane (UN1971) and Hydrogen and Methane mixture, compressed (UN2034) are lighter than air and will rise. Hydrogen and Deuterium fires are difficult to detect since they burn with an invisible flame. Use an alternate method of detection (thermal camera, broom handle, etc.) Vapors may travel to source of ignition and flash back. Cylinders exposed to fire may vent and release flammable gas through pressure relief devices. Containers may explode when heated. Ruptured cylinders may rocket. CAUTION: When LNG - Liquefied natural gas (UN1972) is released on or near water, product may vaporize explosively. (ERG, 2024)

Health Hazard

Excerpt from ERG Guide 115 [Gases - Flammable (Including Refrigerated Liquids)]:

Vapors may cause dizziness or asphyxiation without warning, especially when in closed or confined areas. Some may be irritating if inhaled at high concentrations. Contact with gas, liquefied gas or cryogenic liquids may cause burns, severe injury and/or frostbite. Fire may produce irritating and/or toxic gases. (ERG, 2024)

Reactivity Profile

Finely divided platinum and some other metals will cause a mixture of hydrogen and oxygen to explode at ordinary temperatures. If a jet of hydrogen in air impinges on platinum black the metal surface gets hot enough to ignite the gases, [Mellor 1:325(1946-1947)]. Explosive reactions occur upon ignition of mixtures of nitrogen trifluoride with good reducing agents such as ammonia, hydrogen, hydrogen sulfide or methane. Mixtures of hydrogen, carbon monoxide, or methane and oxygen difluoride are exploded when a spark is discharged, [Mellor 2, Supp. 1:192(1956)]. An explosion occurred upon heating 1'-pentol and 1"-pentol under hydrogen pressure. It appears that this acetylenic compound under certain conditions suddenly breaks down to form elemental carbon, hydrogen, and carbon monoxide with the release of sufficient energy to develop pressures in excess of 1000 atmospheres, [AIChE Loss Prevention, p1, (1967)].

Belongs to the Following Reactive Group(s)

• Reducing Agents, Weak

Potentially Incompatible Absorbents

No information available.

Response Recommendations

Isolation and Evacuation

Excerpt from ERG Guide 115 [Gases - Flammable (Including Refrigerated Liquids)]:

IMMEDIATE PRECAUTIONARY MEASURE: Isolate spill or leak area for at least 100 meters (330 feet) in all directions.

LARGE SPILL: Consider initial downwind evacuation for at least 800 meters (1/2 mile).

FIRE: If tank, rail tank car or highway tank is involved in a fire, ISOLATE for 1600 meters (1 mile) in all directions; also, consider initial evacuation for 1600 meters (1 mile) in all directions. In fires involving Liquefied Petroleum Gases (LPG) (UN1075), Butane (UN1011), Butylene (UN1012), Isobutylene (UN1055), Propylene (UN1077), Isobutane (UN1969), and Propane (UN1978), also refer to the "BLEVE - Safety Precautions" section. (ERG, 2024)

Firefighting

Excerpt from ERG Guide 115 [Gases - Flammable (Including Refrigerated Liquids)]:

DO NOT EXTINGUISH A LEAKING GAS FIRE UNLESS LEAK CAN BE STOPPED. CAUTION: Hydrogen (UN1049), Deuterium (UN1957), Hydrogen, refrigerated liquid (UN1966) and Hydrogen and Methane mixture, compressed (UN2034) will burn with an invisible flame. Use an alternate method of detection (thermal camera, broom handle, etc.).

SMALL FIRE: Dry chemical or CO2.

LARGE FIRE: Water spray or fog. If it can be done safely, move undamaged containers away from the area around the fire. CAUTION: For LNG - Liquefied natural gas (UN1972) pool fires, DO NOT USE water. Use dry chemical or high-expansion foam.

FIRE INVOLVING TANKS: Fight fire from maximum distance or use unmanned master stream devices or monitor nozzles. Cool containers with flooding quantities of water until well after fire is out. Do not direct water at source of leak or safety devices; icing may occur. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks in direct contact with flames. For massive fire, use unmanned master stream devices or monitor nozzles; if this is impossible, withdraw from area and let fire burn. (ERG, 2024)

Non-Fire Response

Excerpt from ERG Guide 115 [Gases - Flammable (Including Refrigerated Liquids)]:

ELIMINATE all ignition sources (no smoking, flares, sparks or flames) from immediate area. All equipment used when handling the product must be grounded. Do not touch or walk through spilled material. Stop leak if you can do it without risk. If possible, turn leaking containers so that gas escapes rather than liquid. Use water spray to reduce vapors or divert vapor cloud drift. Avoid allowing water runoff to contact spilled material. Do not direct water at spill or source of leak. CAUTION: For LNG - Liquefied natural gas (UN1972), DO NOT apply water, regular or alcohol-resistant foam directly on spill. Use a high-expansion foam if available to reduce vapors. Prevent spreading of vapors through sewers, ventilation systems and confined areas. Isolate area until gas has dispersed. CAUTION: When in contact with refrigerated/cryogenic liquids, many materials become brittle and are likely to break without warning. (ERG, 2024)

Protective Clothing

Excerpt from ERG Guide 115 [Gases - Flammable (Including Refrigerated Liquids)]:

Wear positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing provides thermal protection but only limited chemical protection. Always wear thermal protective clothing when handling refrigerated/cryogenic liquids. (ERG, 2024)

DuPont Tychem® Suit Fabrics

No information available.

First Aid

Excerpt from ERG Guide 115 [Gases - Flammable (Including Refrigerated Liquids)]:

Refer to the "General First Aid" section. Specific First Aid: Clothing frozen to the skin should be thawed before being removed. In case of contact with liquefied gas, only medical personnel should attempt thawing frosted parts. In case of burns, immediately cool affected skin for as long as possible with cold water. Do not remove clothing if adhering to skin. (ERG, 2024)

Physical Properties

Chemical Formula: H2

Flash Point: data unavailable

Lower Explosive Limit (LEL): 4 % (USCG, 1999) Upper Explosive Limit (UEL): 75 % (USCG, 1999) Autoignition Temperature: 1065°F (USCG, 1999) Melting Point: -434°F (USCG, 1999) Vapor Pressure: data unavailable

Vapor Density (Relative to Air): data unavailable

Specific Gravity: 0.071 at -423.4°F (USCG, 1999) - Less dense than water; will float

Boiling Point: -423°F at 760 mmHg (USCG, 1999)

Molecular Weight: 2 (USCG, 1999)

Water Solubility: data unavailable

Ionization Energy/Potential: data unavailable

IDLH: data unavailable

AEGLs (Acute Exposure Guideline Levels)

No AEGL information available.

ERPGs (Emergency Response Planning Guidelines)

No ERPG information available.

PACs (Protective Action Criteria)

Chemical	PAC-1	PAC-2	PAC-3	
Hydrogen (1333-74-0)	65000 ppm 👋 👋 👋	230000 ppm 👋 👋 👋	400000 ppm 👋 👋 👋	LEL = 40000 ppm

♥ ♥ ♥ indicates value is 100% or more of LEL.

(DOE, 2024)

Regulatory Information

EPA Consolidated List of Lists

Regulatory Name	CAS Number/ 313 Category Code	EPCRA 302 EHS TPQ	EPCRA 304 EHS RQ	CERCLA RQ	EPCRA 313 TRI	RCRA Code	CAA 112(r) RMP TQ
Hydrogen	1333-74-0						10000 pounds

(EPA List of Lists, 2024)

CISA Chemical Facility Anti-Terrorism Standards (CFATS)

		RELEASE			THEFT			SABOTAGE		
Chemical of Interest	CAS Number	Min Conc	STQ	Security Issue	Min Conc	STQ	Security Issue	Min Conc	STQ	Security Issue
Hydrogen	1333-74-0	1.00 %	10000 pounds	flammable						

(CISA, 2007)

OSHA Process Safety Management (PSM) Standard List

METHANOL



Chemical Identifiers

CAS Number	UN/NA Number	DOT Hazard Label	USCG CHRIS Code
67-56-1 🔎	1230	Flammable Liquid Poison (international)	MAL
NIOSH Pocket G	uide	International Chem Safet	y Card
Methyl alcohol		METHANOL	

NFPA 704

Diamond	Hazard	Value	Description
3	Health	1	Can cause significant irritation.
10	+ Flammability	3	Can be ignited under almost all ambient temperature conditions.
	Instability	0	Normally stable, even under fire conditions.
	Special		

(NFPA, 2010)

General Description

A colorless fairly volatile liquid with a faintly sweet pungent odor like that of ethyl alcohol. Completely mixes with water. The vapors are slightly heavier than air and may travel some distance to a source of ignition and flash back. Any accumulation of vapors in confined spaces, such as buildings or sewers, may explode if ignited. Used to make chemicals, to remove water from automotive and aviation fuels, as a solvent for paints and plastics, and as an ingredient in a wide variety of products.

Hazards

Reactivity Alerts

Highly Flammable

Air & Water Reactions

Highly flammable. Soluble in water in all proportions.

Fire Hazard

Behavior in Fire: Containers may explode. (USCG, 1999)

Health Hazard

Exposure to excessive vapor causes eye irritation, head- ache, fatigue and drowsiness. High concentrations can produce central nervous system depression and optic nerve damage. 50,000 ppm will probably cause death in 1 to 2 hrs. Can be absorbed through skin. Swallowing may cause death or eye damage. (USCG, 1999)

Reactivity Profile

METHANOL reacts violently with acetyl bromide [Merck 11th ed. 1989]. Mixtures with concentrated sulfuric acid and concentrated hydrogen peroxide can cause explosions. Reacts with hypochlorous acid either in water solution or mixed water/carbon tetrachloride solution to give methyl hypochlorite, which decomposes in the cold and may explode on exposure to sunlight or heat. Gives the same product with chlorine. Can react explosively with isocyanates under basic conditions. The presence of an inert solvent mitigates this reaction [Wischmeyer 1969]. A violent exothermic reaction occurred between methyl alcohol and bromine in a mixing cylinder [MCA Case History 1863. 1972]. A flask of anhydrous lead perchlorate dissolved in methanol exploded when it was disturbed [J. Am. Chem. Soc. 52:2391. 1930]. P4O6 reacts violently with methanol. (Thorpe, T. E. et al., J. Chem. Soc., 1890, 57, 569-573). Ethanol or methanol can ignite on contact with a platinum-black catalyst. (Urben 1794).

Belongs to the Following Reactive Group(s)

• Alcohols and Polyols

Potentially Incompatible Absorbents

Use caution: Liquids with this reactive group classification have been known to react with the absorbent listed below.

Cellulose-Based Absorbents

Response Recommendations

Isolation and Evacuation

Excerpt from ERG Guide 131 [Flammable Liquids - Toxic]:

IMMEDIATE PRECAUTIONARY MEASURE: Isolate spill or leak area for at least 50 meters (150 feet) in all directions.

SPILL: Increase the immediate precautionary measure distance, in the downwind direction, as necessary.

FIRE: If tank, rail tank car or highway tank is involved in a fire, ISOLATE for 800 meters (1/2 mile) in all directions; also, consider initial evacuation for 800 meters (1/2 mile) in all directions. (ERG, 2024)

Firefighting

Excerpt from ERG Guide 131 [Flammable Liquids - Toxic]:

CAUTION: The majority of these products have a very low flash point. Use of water spray when fighting fire may be inefficient. CAUTION: Methanol (UN1230) will burn with an invisible flame. Use an alternate method of detection (thermal camera, broom handle, etc.).

SMALL FIRE: Dry chemical, CO2, water spray or alcohol-resistant foam.

LARGE FIRE: Water spray, fog or alcohol-resistant foam. If it can be done safely, move undamaged containers away from the area around the fire. Dike runoff from fire control for later disposal. Avoid aiming straight or solid streams directly onto the product.

FIRE INVOLVING TANKS, RAIL TANK CARS OR HIGHWAY TANKS: Fight fire from maximum distance or use unmanned master stream devices or monitor nozzles. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay

away from tanks in direct contact with flames. For massive fire, use unmanned master stream devices or monitor nozzles; if this is impossible, withdraw from area and let fire burn. (ERG, 2024)

Non-Fire Response

Excerpt from ERG Guide 131 [Flammable Liquids - Toxic]:

ELIMINATE all ignition sources (no smoking, flares, sparks or flames) from immediate area. All equipment used when handling the product must be grounded. Do not touch or walk through spilled material. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. A vapor-suppressing foam may be used to reduce vapors.

SMALL SPILL: Absorb with earth, sand or other non-combustible material and transfer to containers for later disposal. Use clean, non-sparking tools to collect absorbed material.

LARGE SPILL: Dike far ahead of liquid spill for later disposal. Water spray may reduce vapor, but may not prevent ignition in closed spaces. (ERG, 2024)

Protective Clothing

Approved canister mask for high vapor concentrations; safety goggles; rubber gloves. (USCG, 1999)

DuPont Tychem® Suit Fabrics

Normalized Breakthrough Times (in Minutes)

Chemical	CAS Number	State	QS	QC	SL	C3	TF	ТР	RC	ТК	RF
Methanol	67-56-1	Liquid		imm	>480	imm	117	117	>480	>480	>480

> indicates greater than.

"imm" indicates immediate; having a normalized breakthrough time of 10 minutes or less.

Special Warning from DuPont: Tychem® and Tyvek® fabrics should not be used around heat, flames, sparks or in potentially flammable or explosive environments. Only...

(DuPont, 2024)

First Aid

EYES: First check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20 to 30 minutes while simultaneously calling a hospital or poison control center. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. IMMEDIATELY transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop.

SKIN: IMMEDIATELY flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. If symptoms such as redness or irritation develop, IMMEDIATELY call a physician and be prepared to transport the victim to a hospital for treatment.

INHALATION: IMMEDIATELY leave the contaminated area; take deep breaths of fresh air. If symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop, call a physician and be prepared to transport the victim to a hospital. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, Self-Contained Breathing Apparatus (SCBA) should be used; if not available, use a level of protection greater than or equal to that advised under Protective Clothing.

INGESTION: DO NOT INDUCE VOMITING. Volatile chemicals have a high risk of being aspirated into the victim's lungs during vomiting which increases the medical problems. If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and IMMEDIATELY call a hospital or poison control center. IMMEDIATELY transport the victim to a hospital. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. DO NOT INDUCE VOMITING. IMMEDIATELY transport the victim to a hospital. (NTP, 1992)

Physical Properties

Chemical Formula: CH4O

Flash Point: 52°F (NTP, 1992)

Lower Explosive Limit (LEL): 6 % (NTP, 1992)

Upper Explosive Limit (UEL): 36.5 % (NTP, 1992)

Autoignition Temperature: 867°F (USCG, 1999)

Melting Point: -144°F (NTP, 1992)

Vapor Pressure: 100 mmHg at 70.2°F ; 237.87 mmHg at 100°F (NTP, 1992)

Vapor Density (Relative to Air): 1.11 (NTP, 1992) - Heavier than air; will sink

Specific Gravity: 0.792 at 68°F (USCG, 1999) - Less dense than water; will float

Boiling Point: 148.3°F at 760 mmHg (NTP, 1992)

Molecular Weight: 32.04 (NTP, 1992)

Water Solubility: greater than or equal to 100 mg/mL at 70°F (NTP, 1992)

Ionization Energy/Potential: 10.84 eV (NIOSH, 2024)

IDLH: 6000 ppm (NIOSH, 2024)

AEGLs (Acute Exposure Guideline Levels)

Interim AEGLs for Methanol (67-56-1)									
Exposure Period	AEGL-1	AEGL-2	AEGL-3						
10 minutes	670 ppm	11000 ppm 👋	40000 ppm 👋 👋						
30 minutes	670 ppm	4000 ppm	14000 ppm 👋						
60 minutes	530 ppm	2100 ppm	7200 ppm 👋						
4 hours	340 ppm	730 ppm	2400 ppm						
8 hours	270 ppm	520 ppm	1600 ppm						

Lower Explosive Limit (LEL) = 55000 ppm

indicates value is 10-49% of LEL. Safety consideration against explosions must be taken into account.

indicates value is 50-99% of LEL. Extreme safety consideration against explosions must be taken into account. Level of Distinct Odor Awareness (LOA) = 8.9 ppm

(NAC/NRC, 2024)

ERPGs (Emergency Response Planning Guidelines)

Chemical	ERPG-1	ERPG-2	ERPG-3	
Methanol (67-56-1)	200 ppm	1000 ppm	5000 ppm	

(AIHA, 2022)

PACs (Protective Action Criteria)

Chemical	PAC-1	PAC-2	PAC-3	
Methyl alcohol; (Methanol) (67-56-1)	530 ppm	2100 ppm	7200 ppm 👋	LEL = 55000 ppm

indicates value is 10-49% of LEL.

(DOE, 2024)

Regulatory Information

EPA Consolidated List of Lists

Regulatory Name	CAS Number/ 313 Category Code	EPCRA 302 EHS TPQ	EPCRA 304 EHS RQ	CERCLA RQ	EPCRA 313 TRI	RCRA Code	CAA 112(r) RMP TQ
Methanol	67-56-1			5000 pounds	313	U154	

(EPA List of Lists, 2024)

CISA Chemical Facility Anti-Terrorism Standards (CFATS)

No regulatory information available.

OSHA Process Safety Management (PSM) Standard List

CARBON DIOXIDE



Chemical Identifiers

CAS Number	UN/NA Number	DOT Hazard Label	USCG CHRIS Code
124-38-9 🔎	1013	Non-Flammable Gas	CDO
NIOSH Pocket Guid	le	International Chem Safe	ty Card
Carbon dioxide		CARBON DIOXIDE	

NFPA 704

data unavailable

General Description

A colorless odorless gas at atmospheric temperatures and pressures. Relatively nontoxic and noncombustible. Heavier than air and may asphyxiate by the displacement of air. Soluble in water. Forms carbonic acid, a mild acid. Under prolonged exposure to heat or fire the container may rupture violently and rocket. Used to freeze food, to control chemical reactions, and as a fire extinguishing agent.

Hazards

Reactivity Alerts

none

Air & Water Reactions

Water soluble. Forms carbonic acid, a mild acid in water.

Fire Hazard

Behavior in Fire: Containers may explode when heated. (USCG, 1999)

Health Hazard

Inhalation causes increased respiration rate, headache, subtle physiological changes for up to 5% concentration and prolonged exposure. Higher concentrations can cause unconsciousness and death. Solid can cause cold contact burns. Liquid or cold gas can cause freezing injury to skin or eyes similar to a burn. (USCG, 1999)

Reactivity Profile

Dusts of magnesium, lithium, potassium, sodium, zirconium, titanium, and some magnesium-aluminum alloys, and heated aluminum, chromium, and magnesium when suspended in carbon dioxide are ignitable and explosive. This is especially true in the presence of strong oxidizers, such as peroxides. The presence of carbon dioxide in solutions of aluminum hydride in ether can cause violent decomposition on warming the residue, [J. Amer. Chem. Soc., 1948, 70, 877]. Dangers arising from the use of carbon dioxide in the fire prevention and extinguishing systems of confined volumes of air and flammable vapors are examined. The hazard associated with its use centers around the fact that large electrostatic discharges may be created that initiate explosion, [Quart. Saf. Summ., 1973, 44(1740, 10]. Contact of very cold

liquid/solid carbon dioxide with water may result in vigorous or violent boiling of the product and extremely rapid vaporization due to the large temperature differences involved. If the water is hot, there is the possibility that a liquid "superheat" explosion may occur. Pressures may build to dangerous levels if liquid gas contacts water in a closed container. Forms weak carbonic acid in nonhazardous reaction with water.

Belongs to the Following Reactive Group(s)

• Acids, Weak

Potentially Incompatible Absorbents

No information available.

Response Recommendations

Isolation and Evacuation

Excerpt from ERG Guide 120 [Gases - Inert (Including Refrigerated Liquids)]:

IMMEDIATE PRECAUTIONARY MEASURE: Isolate spill or leak area for at least 100 meters (330 feet) in all directions.

LARGE SPILL: Consider initial downwind evacuation for at least 100 meters (330 feet).

FIRE: If tank, rail tank car or highway tank is involved in a fire, ISOLATE for 800 meters (1/2 mile) in all directions; also, consider initial evacuation for 800 meters (1/2 mile) in all directions. (ERG, 2024)

Firefighting

Excerpt from ERG Guide 120 [Gases - Inert (Including Refrigerated Liquids)]:

Use extinguishing agent suitable for type of surrounding fire. If it can be done safely, move undamaged containers away from the area around the fire. Damaged cylinders should be handled only by specialists.

FIRE INVOLVING TANKS: Fight fire from maximum distance or use unmanned master stream devices or monitor nozzles. Cool containers with flooding quantities of water until well after fire is out. Do not direct water at source of leak or safety devices; icing may occur. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks in direct contact with flames. (ERG, 2024)

Non-Fire Response

Excerpt from ERG Guide 120 [Gases - Inert (Including Refrigerated Liquids)]:

Do not touch or walk through spilled material. Stop leak if you can do it without risk. Use water spray to reduce vapors or divert vapor cloud drift. Avoid allowing water runoff to contact spilled material. Do not direct water at spill or source of leak. If possible, turn leaking containers so that gas escapes rather than liquid. Prevent entry into waterways, sewers, basements or confined areas. Allow substance to evaporate. Ventilate the area. CAUTION: When in contact with refrigerated/cryogenic liquids, many materials become brittle and are likely to break without warning. (ERG, 2024)

Protective Clothing

Excerpt from NIOSH Pocket Guide for Carbon dioxide:

Skin: FROSTBITE - Compressed gases may create low temperatures when they expand rapidly. Leaks and uses that allow rapid expansion may cause a frostbite hazard. Wear appropriate personal protective clothing to prevent the skin from becoming frozen.

Eyes: FROSTBITE - Wear appropriate eye protection to prevent eye contact with the liquid that could result in burns or

tissue damage from frostbite.

Wash skin: No recommendation is made specifying the need for washing the substance from the skin (either immediately or at the end of the work shift).

Remove: No recommendation is made specifying the need for removing clothing that becomes wet or contaminated.

Change: No recommendation is made specifying the need for the worker to change clothing after the workshift.

Provide: FROSTBITE WASH - Quick drench facilities and/or eyewash fountains should be provided within the immediate work area for emergency use where there is any possibility of exposure to liquids that are extremely cold or rapidly evaporating. (NIOSH, 2024)

DuPont Tychem® Suit Fabrics

No information available.

First Aid

Excerpt from NIOSH Pocket Guide for Carbon dioxide:

Eye: FROSTBITE - If eye tissue is frozen, seek medical attention immediately; if tissue is not frozen, immediately and thoroughly flush the eyes with large amounts of water for at least 15 minutes, occasionally lifting the lower and upper eyelids. If irritation, pain, swelling, lacrimation, or photophobia persist, get medical attention as soon as possible.

Skin: FROSTBITE - If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water.

Breathing: RESPIRATORY SUPPORT - If a person breathes large amounts of this chemical, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible. (NIOSH, 2024)

Physical Properties

Chemical Formula: CO2

Flash Point: data unavailable
Lower Explosive Limit (LEL): data unavailable
Upper Explosive Limit (UEL): data unavailable
Autoignition Temperature: data unavailable
Melting Point: -109.3°F (USCG, 1999)
Vapor Pressure: 56.5 atm (NIOSH, 2024)
Vapor Density (Relative to Air): 1.53 (NIOSH, 2024) - Heavier than air; will sink
Specific Gravity: 1.56 at -110.2°F (USCG, 1999) - Denser than water; will sink
Boiling Point: Sublimes (NIOSH, 2024)
Molecular Weight: 44 (USCG, 1999)
Water Solubility: 0.2 % at 77°F (NIOSH, 2024)
Ionization Energy/Potential: 13.77 eV (NIOSH, 2024)
IDLH: 40000 ppm (NIOSH, 2024)
AEGLs (Acute Exposure Guideline Levels)

No AEGL information available.

ERPGs (Emergency Response Planning Guidelines)

No ERPG information available.

PACs (Protective Action Criteria)

Chemical	PAC-1	PAC-2	PAC-3
Carbon dioxide (124-38-9)	54000 mg/m3	72000 mg/m3	90000 mg/m3

(DOE, 2024)

Regulatory Information

EPA Consolidated List of Lists

No regulatory information available.

CISA Chemical Facility Anti-Terrorism Standards (CFATS)

No regulatory information available.

OSHA Process Safety Management (PSM) Standard List

CARBON MONOXIDE



Chemical Identifiers

CAS Number	UN/NA Number	DOT Hazard Label	USCG CHRIS Code
630-08-0 🌽	1016	Poison Gas Flammable Gas	СМО
NIOSH Pocket Guide		International Chem Safety Ca	rd

Carbon monoxide

International Chem Safety Card CARBON MONOXIDE

NFPA 704

Diamond	Hazard	Value	Description
4	Health	3	Can cause serious or permanent injury.
3 0	Flammability	4	Burns readily. Rapidly or completely vaporizes at atmospheric pressure and normal ambient temperature.
	Instability	0	Normally stable, even under fire conditions.
	Special		

(NFPA, 2010)

General Description

Carbon monoxide is a colorless, odorless gas. Prolonged exposure to carbon monoxide rich atmospheres may be fatal. It is easily ignited. It is just lighter than air and a flame can flash back to the source of leak very easily. Under prolonged exposure to fire or intense heat the containers may violently rupture and rocket.

Hazards

Reactivity Alerts

Highly Flammable

Air & Water Reactions

Highly flammable.

Fire Hazard

Special Hazards of Combustion Products: Asphyxiation due to carbon dioxide production may result.

Behavior in Fire: Flame has very little color. Containers may explode in fire. (USCG, 1999)

Health Hazard

Inhalation causes headache, dizziness, weakness of limbs, confusion, nausea, unconsciousness, and finally death. 0.04% conc., 2-3 hr. or 0.06% conc., 1 hr.- headache and discomfort; with moderate exercise, 0.1-0.2% will produce throbbing in the head in about 1/2 hr., a tendency to stagger in about 1 1/2 hr., and confusion of the mind, headache, and nausea in about 2 hrs. 0.20-25% usually produces unconsciousness in about 1/2 hr. Inhalation of a 0.4% conc. can prove fatal in less than 1 hr. Inhalation of high concentrations can cause sudden, unexpected collapse. Contact of liquid with skin will cause frostbite. (USCG, 1999)

Reactivity Profile

Bromine trifluoride and carbon monoxide react explosively at high temperatures or concentrations [Mellor 2 Supp. 1:166 1956]. The same is true for various oxidizers such as: chlorine dioxide, oxygen (liquid), peroxodisulfuryl difluoride. The product of the reaction between lithium and carbon monoxide, lithium carbonyl, detonates violently with water, igniting the gaseous products [Mellor 2, Supp. 2:84 1961]. Potassium and sodium metals behave similarly. Cesium oxide, iron(III) oxide, and silver oxide all react, in the presence of moisture, at ambient temperatures with carbon monoxide causing ignition, [Mellor, 1941, vol. 2, 487]. Contact of very cold liquefied gas with water may result in vigorous or violent boiling of the product and extremely rapid vaporization due to the large temperature differences involved. If the water is hot, there is the possibility that a liquid "superheat" explosion may occur. Pressures may build to dangerous levels if liquid gas contacts water in a closed container [Handling Chemicals Safely 1980].

Belongs to the Following Reactive Group(s)

• Reducing Agents, Weak

Potentially Incompatible Absorbents

No information available.

Response Recommendations

Isolation and Evacuation

Excerpt from ERG Guide 119 [Gases - Toxic - Flammable]:

IMMEDIATE PRECAUTIONARY MEASURE: Isolate spill or leak area for at least 100 meters (330 feet) in all directions.

SPILL: See ERG Table 1 - Initial Isolation and Protective Action Distances on the UN/NA 1016 datasheet.

FIRE: If tank, rail tank car or highway tank is involved in a fire, ISOLATE for 1600 meters (1 mile) in all directions; also, consider initial evacuation for 1600 meters (1 mile) in all directions. (ERG, 2024)

Firefighting

Excerpt from ERG Guide 119 [Gases - Toxic - Flammable]:

DO NOT EXTINGUISH A LEAKING GAS FIRE UNLESS LEAK CAN BE STOPPED.

SMALL FIRE: Dry chemical, CO2, water spray or alcohol-resistant foam.

LARGE FIRE: Water spray, fog or alcohol-resistant foam. FOR CHLOROSILANES, DO NOT USE WATER; use alcohol-resistant foam. If it can be done safely, move undamaged containers away from the area around the fire. Damaged cylinders should be handled only by specialists.

FIRE INVOLVING TANKS: Fight fire from maximum distance or use unmanned master stream devices or monitor nozzles. Cool containers with flooding quantities of water until well after fire is out. Do not direct water at source of leak or safety devices; icing may occur. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks in direct contact with flames. (ERG, 2024)

Non-Fire Response

Excerpt from ERG Guide 119 [Gases - Toxic - Flammable]:

ELIMINATE all ignition sources (no smoking, flares, sparks or flames) from immediate area. All equipment used when handling the product must be grounded. Do not touch or walk through spilled material. Stop leak if you can do it without risk. Do not direct water at spill or source of leak. Use water spray to reduce vapors or divert vapor cloud drift. Avoid allowing water runoff to contact spilled material. FOR CHLOROSILANES, use alcohol-resistant foam to reduce vapors. If possible, turn leaking containers so that gas escapes rather than liquid. Prevent entry into waterways, sewers, basements or confined areas. Isolate area until gas has dispersed. (ERG, 2024)

Protective Clothing

Excerpt from NIOSH Pocket Guide for Carbon monoxide:

Skin: FROSTBITE - Compressed gases may create low temperatures when they expand rapidly. Leaks and uses that allow rapid expansion may cause a frostbite hazard. Wear appropriate personal protective clothing to prevent the skin from becoming frozen.

Eyes: FROSTBITE - Wear appropriate eye protection to prevent eye contact with the liquid that could result in burns or tissue damage from frostbite.

Wash skin: No recommendation is made specifying the need for washing the substance from the skin (either immediately or at the end of the work shift).

Remove: WHEN WET (FLAMMABLE) - Work clothing that becomes wet should be immediately removed due to its flammability hazard (i.e., for liquids with a flash point <100°F).

Change: No recommendation is made specifying the need for the worker to change clothing after the workshift.

Provide: FROSTBITE WASH - Quick drench facilities and/or eyewash fountains should be provided within the immediate work area for emergency use where there is any possibility of exposure to liquids that are extremely cold or rapidly evaporating. (NIOSH, 2024)

DuPont Tychem® Suit Fabrics

Normalized Breakthrough Times (in Minutes)											
Chemical	CAS Number	State	QS	QC	SL	C3	TF	ТР	RC	ТК	RF
Carbon monoxide	630-08-0	Vapor							330	330	330

Normalized Breakthrough Times (in Minutes)

Special Warning from DuPont: Tychem® and Tyvek® fabrics should not be used around heat, flames, sparks or in potentially flammable or explosive environments. Only...

(DuPont, 2024)

First Aid

Excerpt from NIOSH Pocket Guide for Carbon monoxide:

Eye: FROSTBITE - If eye tissue is frozen, seek medical attention immediately; if tissue is not frozen, immediately and thoroughly flush the eyes with large amounts of water for at least 15 minutes, occasionally lifting the lower and upper eyelids. If irritation, pain, swelling, lacrimation, or photophobia persist, get medical attention as soon as possible.

Skin: FROSTBITE - If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water.

Breathing: RESPIRATORY SUPPORT - If a person breathes large amounts of this chemical, move the exposed person to

fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible. (NIOSH, 2024)

Physical Properties

Chemical Formula: CO

Flash Point: data unavailable

Lower Explosive Limit (LEL): 12 % (USCG, 1999)

Upper Explosive Limit (UEL): 75 % (USCG, 1999)

Autoignition Temperature: 1128°F (USCG, 1999)

Melting Point: -326°F (USCG, 1999)

Vapor Pressure: greater than 35 atm (NIOSH, 2024)

Vapor Density (Relative to Air): 0.97 (NIOSH, 2024) - Lighter than air; will rise

Specific Gravity: 0.791 at -312.7°F (USCG, 1999) - Less dense than water; will float

Boiling Point: -312.7°F at 760 mmHg (USCG, 1999)

Molecular Weight: 28 (USCG, 1999)

Water Solubility: 2 % (NIOSH, 2024)

Ionization Energy/Potential: 14.01 eV (NIOSH, 2024)

IDLH: 1200 ppm (NIOSH, 2024)

AEGLs (Acute Exposure Guideline Levels)

Final AEGLs for Carbon monoxide (630-08-0)

Exposure Period	AEGL-1	AEGL-2	AEGL-3
10 minutes	NR	420 ppm	1700 ppm
30 minutes	NR	150 ppm	600 ppm
60 minutes	NR	83 ppm	330 ppm
4 hours	NR	33 ppm	150 ppm
8 hours	NR	27 ppm	130 ppm

NR = Not recommended due to insufficient data

(NAC/NRC, 2024)

ERPGs (Emergency Response Planning Guidelines)

Chemical	ERPG-1	ERPG-2	ERPG-3
Carbon Monoxide (630-08-0)	200 ppm	350 ppm	500 ppm

(AIHA, 2022)

PACs (Protective Action Criteria)

Chemical	PAC-1	PAC-2	PAC-3	
Carbon monoxide (630-08-0)	75 ppm	83 ppm	330 ppm	LEL = 125000 ppm

(DOE, 2024)

Regulatory Information

EPA Consolidated List of Lists

No regulatory information available.

CISA Chemical Facility Anti-Terrorism Standards (CFATS)

No regulatory information available.

OSHA Process Safety Management (PSM) Standard List

Chemical Datasheet

WATER

Chemical Identifiers

CAS Number	UN/NA Number	DOT Hazard Label	USCG CHRIS Code
7732-18-5	none	data unavailable	none
			_
NIOSH Pocket Guide		International Chem Safety Car	rd
none		none	

NFPA 704

data unavailable

General Description

A clear, nontoxic liquid composed of hydrogen and oxygen, essential for life and the most widely used solvent. Include water in a mixture to learn how it could react with other chemicals in the mixture.

Hazards

Reactivity Alerts

none

Air & Water Reactions

No rapid reaction with air. No rapid reaction with water.

Fire Hazard

No information available.

Health Hazard

Water itself is nontoxic and is in fact essential for life. Solutes dissolved in water may be toxic, but those interactions are covered by the reactive groups that the solute belongs to.

Reactivity Profile

Water reacts with many substances, including but not limited to alkali metals, hydrides, strong halogenating agents, and chlorosilanes. These reactions can be hazardous and may result in flammable or toxic gas production, or generation of excessive heat that may cause pressurization to occur. Another reactive hazard is heat of mixing. Mixing substances such as sulfuric acid or sodium hydroxide with water may generate significant heat. Additionally, water is a good solvent for polar molecules, so it can form aqueous solutions if it comes into contact with such molecules.

Belongs to the Following Reactive Group(s)

• Water and Aqueous Solutions

Potentially Incompatible Absorbents

Response Recommendations

Isolation and Evacuation

No information available.

Firefighting

No information available.

Non-Fire Response

No information available.

Protective Clothing

No information available.

DuPont Tychem® Suit Fabrics

No information available.

First Aid

No information available.

Physical Properties

Chemical Formula: H2O

Flash Point: data unavailable Lower Explosive Limit (LEL): data unavailable Upper Explosive Limit (UEL): data unavailable Autoignition Temperature: data unavailable Melting Point: 32°F Vapor Pressure: data unavailable Vapor Density (Relative to Air): data unavailable Specific Gravity: 1 **Boiling Point:** 212°F at 760 mmHg Molecular Weight: data unavailable Water Solubility: data unavailable Ionization Energy/Potential: data unavailable IDLH: data unavailable **AEGLs (Acute Exposure Guideline Levels)** No AEGL information available. **ERPGs (Emergency Response Planning Guidelines)** No ERPG information available. **PACs (Protective Action Criteria)**

Regulatory Information

EPA Consolidated List of Lists

No regulatory information available.

CISA Chemical Facility Anti-Terrorism Standards (CFATS)

No regulatory information available.

OSHA Process Safety Management (PSM) Standard List