Canadian Centre for Occupational Health and Safety

CHEMINFO Chemical Profiles Created by CCOHS

CCOHS Chemical Name: Methanol

REFRESH RECORD

SECTION 1. CHEMICAL IDENTIFICATION

CHEMINFO Record Number: 23
CCOHS Chemical Name: Methanol

Synonyms:

Carbinol
Columbian spirits
Hydroxymethane
Methyl alcohol
Methyl hydrate
Methyl hydroxide
Methylol
Monohydroxymethane
Wood alcohol
Wood naphtha
Wood spirit

Chemical Name French: Méthanol

Chemical Name Spanish: Metanol

CAS Registry Number:	67-56-1
UN/NA Number(s):	1230
RTECS Number(s):	PC1400000
EU EINECS/ELINCS Number:	200-659-6
Chemical Family:	Saturated primary aliphatic alcohol / primary alkanol / primary alkyl alcohol / methanol / methyl alcohol
Molecular Formula:	C-H4-O
Structural Formula:	CH3-OH

Status of Record:

The CHEMINFO record for this chemical is complete. The full format provides a detailed evaluation of health, fire and reactivity hazards, as well as recommendations on topics such as handling and storage, personal protective equipment, accidental release and first aid.

SECTION 2. DESCRIPTION

Appearance and Odour:

Colourless liquid, with a mild, characteristic alcohol odour, when pure.(1,31) Crude methanol may have a repulsive, pungent odour.(1) Hygroscopic (absorbs moisture from the air).(32)

Odour Threshold:

Reported values vary widely; 4.2-5960 ppm (geometric mean: 160 ppm) (detection); 53-8940 ppm (geometric mean: 690 ppm) (recognition) (33)

Warning Properties:

POOR - odour threshold values vary widely. Geometric mean odour threshold is of the same order as the TLV.

Composition/Purity:

Methanol is available in laboratory and commercial grades with purity greater than 99.85%. Methanol is also available as solutions in water. Impurities that have been

identified include carbon dioxide, methyl ether, methylal, methylol, methyl formate, methyl acetate, formaldehyde, acetaldehyde, acetone, ethanol, 2-propanol, 1-butanol, 2-butanol, 2-methyl-2-propanol and water. The concentration of all impurities is small.(37) Methanol is shipped on land by tank cars, trucks and drums, and by sea in tankers or ships. Crude methanol can be used for some applications, such as energy, and specific chemical and technical purposes. Principal impurities include water, higher alcohols, methyl formate and higher esters.(31,34)

Uses and Occurrences:

Methanol is used mainly in chemical synthesis; predominantly in the production of formaldehyde, methyl t-butyl ether, acetic acid, dimethyl terephthalate and methyl methacrylate. It is also used as a feedstock for other organic compounds, such as dimethyl ether, methylamines, methyl halides and glycol methyl ethers; as a solvent; as antifreeze; to protect natural gas pipelines against the formation of gas hydrates at low temperatures; as an absorption agent in gas scrubbers; in drilling mud in oil fields; in refrigeration systems; as an ingredient in products such as shellacs, paints, varnishes, paint thinners and automotive windshield washer fluids, and as a denaturant for ethanol. It is also used in the production of gasoline (MTG process in New Zealand) and, on a small scale, as a motor fuel.(1,31,34) Methanol occurs naturally in blood, urine, saliva and expired air, and is present in fresh fruit and vegetables, fruit juices, fermented beverages and diet foods.(1)

SECTION 3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW:

Colourless liquid, with a mild, characteristic alcohol odour when pure. Crude methanol may have a repulsive, pungent odour. Hygroscopic. FLAMMABLE LIQUID AND VAPOUR. Burns with a clean, clear flame, which is almost invisible in daylight, or a light blue flame. Can decompose at high temperatures forming carbon monoxide and formaldehyde. Confined space toxicity hazard. Mild central nervous system depressant following inhalation, skin absorption or ingestion. May cause headache, nausea, dizziness, drowsiness, and incoordination. Severe vision effects, including increased sensitivity to light, blurred vision, and blindness may develop following an 8-24 hour symptom-free period. Coma and death may result. IRRITANT. Causes eye irritation. Aspiration hazard. Swallowing or vomiting of the liquid may result in aspiration (breathing) into the lungs. POSSIBLE TERATOGEN/EMBRYOTOXIN - may harm the unborn child, based on animal information.

POTENTIAL HEALTH EFFECTS

Effects of Short-Term (Acute) Exposure

Inhalation:

Methanol is toxic and can very readily form extremely high vapour concentrations at room temperature. Inhalation is the most common route of occupational exposure.

At first, methanol causes mild central nervous system (CNS) depression with symptoms such as nausea, headache, vomiting, dizziness, incoordination and an appearance of drunkenness. A time period with no obvious symptoms follows (typically 8-24 hours, but may last several hours to 2 days). This latent period is then followed by development of metabolic acidosis and severe visual effects. Symptoms such as headache, dizziness, nausea and vomiting, followed in more severe cases by abdominal and muscular pain and difficult periodic breathing have been observed. Coma and death, usually

due to respiratory failure, may occur if medical treatment is not received. Visual effects may include reduced reactivity and/or increased sensitivity to light, blurred, double and/or snowy vision, and blindness. Depending on the severity of poisoning and the promptness of treatment, survivors may recover completely or may have permanent blindness, vision disturbances and/or nervous system effects.(1,2,4,5)

Recent reports of toxicity due to inhalation of methanol are relatively rare, possibly due to the implementation of strict control measures. However, there are historical reports of central nervous system effects, impairment of vision and deaths occurring following inhalation of methanol at work.(1,2,4,5) Usually exposure was in a confined space with poor ventilation.(2,4) Most studies do not report actual exposure concentrations. One report has described severe and recurring headaches in employees exposed to 200-300 ppm for an unspecified time.(6)

Skin Contact:

In general, primary alcohols like methanol are not skin irritants. However, insufficient information was located to draw conclusions about the skin irritation potential of methanol. No human information was located. In an unconfirmed animal study, prolonged (24-hour) application caused moderate irritation.

Methanol can be absorbed through the skin and harmful effects have been reported by this route of exposure. In most cases, inhalation exposure would have also occurred at the same time.(2,7) In one case, an employee was exposed to methanol while cleaning out a tank. He was wearing a positive pressure breathing apparatus, but no protective clothing. He developed methanol toxicity with CNS and visual effects, as described in "Inhalation" above. This person had a sunburn, which may have increased his potential for skin absorption.(8)

Eye Contact:

Methanol is a moderate eye irritant, based on animal information. No human information was located.

Inhalation, ingestion or skin absorption of methanol can cause significant disturbances to vision, including blindness. Refer to "Inhalation" above for additional information.

Ingestion:

There have been case reports of accidental or intentional ingestion of methanol, usually in illegal or contaminated alcoholic beverages. Reported effects are the same as those described for "Inhalation" above. There is a wide range of individual susceptibility to the toxic effects of methanol. As little as 15 mL of 40% methanol has resulted in the death of one person, while others have survived following ingestion of 500 mL of the same solution. In general, 300-1000 mg/kg is considered the range of minimum lethal dose for untreated cases of methanol poisoning.(1,2,5) In a study of 25 cases of intentional methanol poisoning, changes in kidney function were seen in 15 patients. The changes were not permanent in the those who survived the exposure.(55)

Methanol can probably be easily aspirated (breathed into the lungs) during ingestion or vomiting, based on its physical properties and comparison to related alcohols. Aspiration of methanol could cause a potentially fatal accumulation of fluid in the lungs (pulmonary edema).

There have been a small number of case reports of parkinsonism (Parkinson's disease or similar disorders that affect the nervous system causing rigid muscles, tremors and impaired motor control) following acute methanol poisoning, sometimes with a delay of several years.(50,54) There is too little information available to draw firm conclusions about the association of methanol poisoning and parkinsonism.

Ingestion is not a typical route of occupational exposure.

Effects of Long-Term (Chronic) Exposure

There is very little information available on the effects of long-term exposure to methanol. Despite their limitations, the available case reports and human population studies suggest that long-term, high-level exposure may cause effects similar to relatively high short-term exposures, for example central nervous system (CNS) effects and vision disorders.(1,5)

Nervous System:

In one report, teaching aides worked at or near spirit duplicating machines that used a 99% methanol duplicating fluid. Exposures ranged from 1 hr/d for 1 d/wk to 8 hr/d for 5 d/wk over 3 years, with exposure concentrations from 365-3080 ppm. Headaches, dizziness and nausea/upset stomach were more commonly reported among employees exposed to methanol.(9)
No conclusions can be drawn from a single case report of a 40-year-old physicist who developed rapidly progressing parkinsonism 6 years after working with methanol for 5 years. There was a possible concurrent exposure to methyl bromide.(54) Parkinsonism is Parkinson's disease or similar disorders that affect the nervous system causing rigid muscles, tremors and impaired motor control.

Skin:

Repeated or prolonged exposure to methanol may cause dry, itchy, scaling skin (dermatitis).(50)

Skin Sensitization:

It is not possible to conclude that methanol is a skin sensitizer based on the limited information located.
One report describes 4 cases of allergic skin disorders developing following contact with methanol. In one case, a laboratory technician developed sensitivity to methanol at work. She tested positive to purified methanol in a patch test. This person had also previously tested positive in a patch test with formaldehyde. In another case, a physician developed sensitivity to ethanol (a closely related alcohol) at work. She subsequently tested positive in a patch test to purified ethanol and methanol. The report did not provide enough details to determine if either of these people was more likely to develop allergies (atopic). The other two cases involved non-occupational exposure.(11) Methanol has produced negative results in one unconfirmed animal test for skin sensitization.

Liver:

No conclusions can be drawn from a historical case report that describes liver enlargement in an employee apparently exposed to extremely high concentrations (1200-8000 ppm) for an unspecified time. These effects were not observed in other employees similarly exposed.(10) There are no further details available.

Eyes/Vision:

In one report, teaching aides worked at or near spirit duplicating machines that used a 99% methanol duplicating fluid. Exposures ranged from 1 hr/d for 1 d/wk to 8 hr/d for 5 d/wk over 3 years, with exposure concentrations from 365-3080 ppm. Eye irritation and blurred vision were more commonly reported among employees exposed to methanol.(9)
No conclusions can be drawn from a historical case report that describes a temporary, marked reduction in vision in an employee apparently exposed to extremely high concentrations (1200-8000 ppm) for an unspecified time. These effects were not observed in other employees similarly exposed.(10) There are no further details available.
Short-term inhalation, ingestion or skin absorption of methanol can cause significant disturbances to vision, including blindness.

Carcinogenicity:

Methanol is not known to cause cancer. No human information was located. A well-conducted oral study using rats suggests that methanol may cause cancer, but further research is required before firm conclusions can be drawn. Limited inhalation studies in mice, rats and monkeys have not shown carcinogenicity.

The International Agency for Research on Cancer (IARC) has not evaluated the carcinogenicity of this chemical.

The American Conference of Governmental Industrial Hygienists (ACGIH) has not assigned a carcinogenicity designation to this chemical.

The US National Toxicology Program (NTP) has not listed this chemical in its report on carcinogens.

Teratogenicity and Embryotoxicity:

Methanol is considered a developmental hazard, based on animal information. The developmental toxicity information on methanol is difficult to interpret because it is well known that some animal species metabolize methanol differently than people. However, it is considered prudent to treat methanol as a developmental toxin based on the available information. Methanol has caused fetotoxic or teratogenic effects, in the absence of maternal toxicity in animal studies.
There is little human information available. Some evidence suggests that women with low folic acid intake may be more susceptible to adverse developmental effects of methanol.(51) In a study that reviewed a variety of occupations and exposure to chemicals, no association was found between methanol exposure of the mothers and the incidence of cleft palate.(56) This study is limited by the small numbers of workers exposed to methanol, lack of exposure data and concurrent exposures to other chemicals.

Reproductive Toxicity:

No human information was located. Animal information does not suggest that methanol is a reproductive toxin.

Mutagenicity:

No human information was located. In animal studies, a positive result was obtained in a limited oral study using mice. However, other oral and inhalation studies using rats and mice have given negative results. Mostly negative results have been obtained in cultured mammalian cells, bacteria and fruit flies (Drosophila).

Toxicologically Synergistic Materials:

In animals, high concentrations of methanol can increase the toxicity of other chemicals, particularly liver toxins like carbon tetrachloride.(1,2) Ethanol significantly decreases the toxicity of methanol, because it competes for the same metabolic enzymes, and has been used to treat methanol poisoning.(50)

Potential for Accumulation:

Methanol is readily absorbed into the body following inhalation and ingestion. Skin absorption may occur if the skin is broken or exposure is prolonged. Once absorbed, methanol is rapidly distributed to body tissues. A small amount is excreted unchanged in exhaled air and the urine. The rest is first metabolized to formaldehyde, which is then metabolized to formic acid and/or formate. The formic acid and formate are eventually converted to carbon dioxide and water. It is the difference in the rate of formate

metabolism that accounts for the difference in toxicity of methanol among species.(1,2,5,13,50)
In humans, methanol clears from the body, after inhalation or oral exposure, with a half-life of 1 day or more for high doses (greater than 1000 mg/kg) or about 1.5-3 hours for low doses (less than 100 mg/kg or 76.5-230 ppm (100-300 mg/m3)).(1,13,57)
Methanol has been found in mother's milk.(1)

SECTION 4. FIRST AID MEASURES

Inhalation:

This chemical is toxic and flammable. Take proper precautions to ensure your own safety before attempting rescue (e.g. wear appropriate protective equipment and remove any sources of ignition). Remove source of contamination or move victim to fresh air. Immediately transport victim to an emergency care facility.

Skin Contact:

Avoid direct contact. Wear chemical protective clothing, if necessary. As quickly as possible, remove contaminated clothing, shoes and leather goods (e.g. watchbands, belts). Immediately flush with lukewarm, gently flowing water for 15-20 minutes. Immediately obtain medical attention. Completely decontaminate clothing, shoes and leather goods before re-use or discard.

Eye Contact:

Avoid direct contact. Wear chemical protective gloves, if necessary. Immediately flush the contaminated eye(s) with lukewarm, gently flowing water for 15-20 minutes, while holding the eyelid(s) open. If a contact lens is present, DO NOT delay irrigation or attempt to remove the lens until flushing is done. Take care not to rinse contaminated water into the unaffected eye or onto the face. Immediately obtain medical attention.

Ingestion:

NEVER give anything by mouth if victim is rapidly losing consciousness, is unconscious or convulsing. Have victim rinse mouth thoroughly with water. DO NOT INDUCE VOMITING. If vomiting occurs naturally, have victim lean forward to reduce risk of aspiration. Have victim rinse mouth with water again. Quickly transport victim to an emergency care facility.

First Aid Comments:

Provide general supportive measures (comfort, warmth, rest). Consult a doctor and/or the nearest Poison Control Centre for all exposures.
All first aid procedures should be periodically reviewed by a doctor familiar with the material and its conditions of use in the workplace.

Note to Physicians:

The severity of outcome following methanol ingestion may be more related to the time between ingestion and treatment, rather than the amount ingested. Therefore, there is a need for rapid treatment of any ingestion exposure.(1) Both ethanol and fomepizole are effective antidotes for methanol poisoning, although fomepizole is preferred. See references 58 and 59 for additional information.

SECTION 5. FIRE FIGHTING MEASURES

Flash Point:

11 deg C (52 deg F) (closed cup) (31,35); also reported as 12.2 deg C (54 deg F) (closed cup) (1,34)

Lower Flammable (Explosive) Limit (LFL/LEL):

5.5% (1,34); 6% (31,35)

Upper Flammable (Explosive) Limit (UFL/UEL):

36% (31,35); 44% (1,34)

Autoignition (Ignition) Temperature:

Reported values vary; 385 deg C (725 deg F) (36); 464 deg C (867 deg F) (31,35); 470 deg C (878 deg F) (1,34,36)

Electrical Conductivity:

4.4 x 10(7) pS/m at 18 deg C.(38,43) One source states that pure, anhydrous methanol has a very low electrical conductivity, but no data is given to support this statement.(34)

Minimum Ignition Energy:

0.14 millijoules at 14.7% (39,43)

Flammable Properties:

Flammable liquid. Can readily form explosive mixtures with air at or above 11 deg C, over a wide concentration range. Has a low minimum ignition energy. Burns with a clear, almost invisible, or non-luminous light blue flame.(34,60) Mixtures of methanol and water at concentrations greater than 20% methanol can burn.

Specific Hazards Arising from the Chemical:

During a fire, carbon monoxide, carbon dioxide and irritating and toxic gases such as formaldehyde may be generated. Can accumulate in confined spaces, resulting in a toxicity and flammability hazard. Closed containers may rupture violently and suddenly release large amounts of product when exposed to fire or excessive heat for a sufficient period of time.

Extinguishing Media:

Carbon dioxide, dry chemical powder, appropriate foam, water spray or fog. Water may be effective for cooling, but may not be effective for extinguishing a fire because it will not cool methanol below its flash point.(35) Fire fighting foams, such as multipurpose alcohol-resistant foams, are recommended for most flammable liquid fires.(35) General purpose synthetic foams or protein foams may work, but much less effectively. Foam manufacturers should be consulted for recommendations regarding types of foams and application rates.

Fire Fighting Instructions:

Evacuate area and fight fire from a safe distance or protected location. Approach fire from upwind to avoid toxic methanol and its decomposition products. Note that methanol burns with a clear, almost invisible light blue flame.

Stop leak before attempting to stop the fire. If the leak cannot be stopped, and if there is no risk to the surrounding area, let the fire burn itself out. If the flames are extinguished without stopping the leak, vapours could form explosive mixtures with air and reignite. Water can extinguish the fire if used under favourable conditions and when hose streams are applied by experienced firefighters trained in fighting all types of flammable liquid fires.

Closed containers may rupture violently when exposed to the heat of fire and suddenly release large amounts of products. Always stay away from ends of tanks, but be aware that flying material (shrapnel) from ruptured tanks may travel in any direction. If possible, isolate materials not yet involved in the fire and move containers from fire area if this can be done without risk. Protect personnel. Otherwise, cool fire-exposed containers, tanks or equipment by applying hose

streams. Cooling should begin as soon as possible (within several minutes) and should concentrate on any unwetted portions of the container. Apply water from the side and a safe distance. Cooling should continue until well after the fire is out. If this is not possible, use unmanned monitor nozzles and immediately evacuate the area.
If a leak or spill has not ignited, use water spray in large quantities to disperse the vapours and to protect personnel attempting to stop the leak. Water spray can be used to flush spills away from ignition sources and to dilute spills to non-flammable mixtures. Dike fire control water for appropriate disposal. Solid streams of water may be ineffective and spread material.
For an advanced or massive fire in a large area, use unmanned hose holders or monitor nozzles; if this is not possible withdraw from fire area and allow fire to burn. Withdraw immediately in case of rising sound from venting safety device or any discolouration of tank.
After the fire has been extinguished, toxic atmospheres may remain. Before entering such an area, especially confined areas, check the atmosphere with an appropriate monitoring device while wearing a full protective suit.

Protection of Fire Fighters:

Methanol and it decomposition products are hazardous to health. Do not enter without wearing specialized equipment suitable for the situation. Firefighter's normal protective clothing (Bunker Gear) will not provide adequate protection. Chemical protective clothing (e.g. chemical splash suit) and positive pressure self-contained breathing apparatus (NIOSH approved or equivalent) may be necessary.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) HAZARD IDENTIFICATION

NFPA - Health:	1 - Exposure would cause significant irritation, but only minor residual injury.
NFPA - Flammability:	3 - Liquids and solids that can be ignited under almost all ambient temperature conditions.
NFPA - Instability:	0 - Normally stable, even under fire conditions, and not reactive with water.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Spill Precautions:

Restrict access to area until completion of cleanup. Ensure cleanup is conducted by trained personnel only. Wear adequate personal protective equipment.
Extinguish or remove all ignition sources. Notify government occupational health and safety and environmental authorities.

Clean-up:

Do not touch spilled material. Prevent material from entering sewers, waterways or confined spaces.
Stop or reduce leak if safe to do so. Contain spill with earth, sand, or absorbent material which does not react with spilled material. Remove liquid by pumps or vacuum equipment. Place in suitable, covered, labelled containers.
SMALL SPILLS: Soak up spill with absorbent material which does not react with spilled chemical. Put material in suitable, covered, labelled containers. Flush area with water.
Contaminated absorbent material may pose the same hazards as the spilled product.

LARGE SPILLS: Contact fire and emergency services and supplier for advice.

SECTION 7. HANDLING AND STORAGE

Handling:

This material is a VERY TOXIC (INHALATION/SKIN ABSORPTION HAZARD, POSSIBLE TERATOGEN/EMBRYOTOXIN (affecting pregnant women)), FLAMMABLE liquid. This material is also an eye irritant and it can present a significant hazard in confined space. Before handling, it is very important that engineering controls are operating and that protective equipment requirements and personal hygiene measures are being followed. People working with this material should be properly trained regarding its hazards and its safe use. Maintenance and emergency personnel should be informed of the potential hazards.

Immediately report leaks or ventilation failures.

If methanol is released, evacuate the area. Be aware of typical signs and symptoms of poisoning and first aid procedures. Effects may be delayed from 8 to 24 hours. Any signs of illness should be reported immediately to supervisory personnel. Unprotected persons should avoid all contact with this chemical including contaminated equipment. If methanol is being used in a confined space, all confined space safety procedures should be carefully followed. Continuous air monitoring will probably be necessary to determine if there is adequate ventilation.

Do not heat methanol container. Eliminate all ignition sources (e.g. sparks, open flames, hot surfaces).

Closed handling systems for processes involving this material should be used. If this is not possible, use in smallest possible amounts in well-ventilated area, separate from the storage area. Prevent release of vapour and mist into workplace air.

To reduce the fire/explosion hazard, consider the use of an inert gas in the container or storage vessel. Never perform any welding, cutting, soldering, drilling or other hot work on an empty vessel, container or piping until all liquid and vapours have been cleared. Post "NO SMOKING" signs. Keep aisles and exits free of obstruction. It is very important to keep areas where this material is used clear of other materials which can burn (e.g., cardboard, sawdust).

Do not use with incompatible materials such as strong oxidizing agents, mineral and organic acids and metals. See Incompatibilities - Materials to Avoid Section for more information.

Use non-sparking ventilation systems, approved explosion-proof equipment and intrinsically safe electrical systems in areas of use. For large-scale operations, consider the installation of leak and fire detection equipment along with a suitable, automatic fire suppression system.

Make sure containers are labelled clearly. Avoid damaging containers. Regularly check containers for evidence of corrosion or leakage.

Keep aisles and exits free of obstruction. To prevent sparking, generously wet hard surfaces before they are chipped, ground, etc, in potentially hazardous areas.

During transfer operations containers and vessels should be electrically grounded and bonded to prevent the build-up of a static charge. Ground all drums, transfer vessels, hoses and piping. Ground clips must contact bare metal. When dispensing in other than a closed system, ensure dispensing container is bonded to receiving transfer equipment and container. Do not dispense in storage area unless dispensing area is segregated by fire-resistant construction.

Never return contaminated material to its original container. Keep containers closed when not in use. Empty containers may contain hazardous residues.

A preventive maintenance plan is recommended which includes all methanol handling equipment, storage vessels, instrumentation, safety devices and auxiliary services which power or supply this equipment.

Follow handling precautions on Material Safety Data Sheet. Have suitable emergency equipment for fires, spills and leaks readily available. Practice good housekeeping. Comply with applicable regulations. Have suitable emergency equipment for fires,

spills and leaks readily available.

Storage:

Store this material in a cool, dry, well-ventilated area away from oxidizing materials and corrosive atmospheres, in a fireproof area. Keep amount in storage to a minimum.
Storage area should be clearly identified, clear of obstruction and accessible only to trained and authorized personnel. Post warning signs. Keep storage area separate from work areas. Do not store below ground level, or in confined spaces. Ground floor storage facilities are usually recommended. Store away from work process and production areas, elevators, loading docks, building and room exits or main aisles leading to exits. Post warning signs. Have appropriate fire extinguishers and spill clean-up equipment in or near storage area.
Check compatibility with other materials. Keep apart at the appropriate distance, as recommended by the supplier. Store away from strong oxidizers, mineral acids and metals. See Incompatibilities - Materials to Avoid section for more information.
Ground all containers and storage vessels. Store away from heat and ignition sources and out of direct sunlight. Post storage area as a 'No Smoking' area.
Keep storage area clear of burnable materials (e.g. old rags, cardboard). Lighted cigarettes, matches, or any other ignition sources should not be allowed around indoor or outdoor storage areas.
Inspect all incoming container to make sure they are properly labelled and not damaged. Always store in original containers. Protect the label and keep it visible.
Inspect containers regularly for leakage or expired shelf life. Replace defective containers. Have replacement containers and labels on hand. Container caps should be properly secured. Store containers at a convenient height for handling, below eye level if possible. Keep containers tightly closed when not in use.
Avoid bulk storage indoors. Store in isolated fireproof building, if possible. Outdoor container storage should be weatherproofed and have proper drainage. Storage tanks should be above ground, over an area sealed on the bottom and diked to hold entire contents.
Protect from temperature extremes. Follow suppliers' advice for storage temperatures. Alarms that warn of temperatures higher or lower than recommended may be necessary.
Keep empty containers in separate storage area. Protect from damage. Empty containers may contain hazardous residues. Keep closed.
Contain spills or leaks by storing in trays made from compatible materials. Keep absorbents for leaks and spills readily available. Provide raised sills or ramps at doorways or create a trench which drains to a safe location. Floors should be sealed to prevent absorption.
Storage facilities should be made of fire resistant materials. Use a grounded, non-sparking ventilation system, approved explosion-proof equipment and intrinsically safe electrical systems. Consider leak detection and alarm equipment for storage area.
Store according to occupational health and safety regulations and fire and building codes which will describe the kind of storage area and the type of storage containers for a specified amount of material. Follow any special instructions for storage on Material Safety Data Sheet (e.g. maximum storage quantities).

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

NOTE: Exposure to this material can be controlled in many ways. The measures appropriate for a particular worksite depend on how this material is used and on the extent of exposure. This general information can be used to help develop specific control measures. Ensure that control systems are properly designed and maintained. Comply with occupational, environmental, fire, and other applicable regulations.

Sampling and Analysis:

Use appropriate instrumentation and sampling strategy (location, timing, duration, frequency, and number of samples). Interpretation of the sampling results is related

to these variables and the analytical method. Sampling should be carried out by trained personnel.

OSHA Analytical Methods:

OSHA METHOD - ID-91. US Department of Labor (68) Validated method. Collection on 2 Anasorb 747 sorbent tubes connected in series. Desorption with carbon disulfide/dimethyl formamide solution. Analysis by gas chromatography with FID detector. Estimated detection limit: 0.9 ug.

NIOSH Analytical Methods:

NIOSH METHOD 2000 - NIOSH manual of analytical methods. (67) Fully evaluated method. Collection on silica gel sorbent tube. Desorption with water. Analysis by gas chromatography with FID detector. Estimated detection limit: 10 micrograms (ug)

Direct Reading Instrumentation:

Methods of detection in commercially available devices which may be suitable: flame ionization detector, gas chromatograph analyzer, extractive FTIR spectrometry.

Colorimetric Detector Tubes:

Commercially available for methanol.

Passive Sampling Devices:

Commercially available.

Engineering Controls:

Engineering methods to control hazardous conditions are preferred. Methods include mechanical (local exhaust) ventilation, process or personnel enclosure and control of process conditions. Administrative controls and personal protective equipment may also be required.

Because of the high potential hazard associated with this substance, stringent control measures such as enclosure (closed handling systems) should be considered. To reduce the fire/explosion hazard, consider the use of an inert gas in the process system.

Use approved explosion-proof equipment and intrinsically safe electrical systems in areas of use. For large-scale operations, consider the installation of leak and fire detection equipment along with a suitable, automatic fire suppression system.

Use a non-sparking, grounded, ventilation system separate from other exhaust ventilation systems. Exhaust directly to the outside.

Supply sufficient replacement air to make up for air removed by exhaust system.

Personal Protective Equipment:

If engineering controls and work practices are not effective in controlling exposure to this material, then wear suitable personal protective equipment including approved respiratory protection. Have appropriate equipment available for use in emergencies such as spills or fire.

If respiratory protection is required, institute a complete respiratory protection program including selection, fit testing, training, maintenance and inspection. Refer to the CSA Standard Z94.4-02, "Selection, Care, and Use of Respirators" available from the Canadian Standards Association.

Respiratory Protection Guidelines:

NIOSH/OSHA RECOMMENDATIONS FOR METHYL ALCOHOL CONCENTRATIONS IN AIR (47):

Up to 2000 ppm: SAR

Up to 5000 ppm: SAR operated in a continuous-flow mode.

Up to 6000 ppm: SAR with a tight-fitting facepiece operated in a continuous- flow mode; or Full-facepiece SCBA or Full-facepiece SAR.

EMERGENCY OR PLANNED ENTRY INTO UNKNOWN CONCENTRATIONS OR IDLH CONDITIONS: Positive pressure, full-facepiece SCBA; or Positive pressure, full-facepiece SAR with an auxiliary positive pressure SCBA.

NOTE: The IDLH concentration for methanol is 6000 ppm.
NOTE: The purpose of establishing an IDLH value is to ensure that the worker can escape from a given contaminated environment in the event of failure of the most protective respiratory protection equipment. In the event of failure of respiratory protective equipment every effort should be made to exit immediately.
ABBREVIATIONS: SAR = supplied-air respirator; SCBA = self-contained breathing apparatus; IDLH = immediately dangerous to life or health.

Eye/Face Protection:

Chemical safety goggles. A face shield may also be necessary.

Skin Protection:

Chemical protective gloves, coveralls, boots, and/or other chemical protective clothing. Have a safety shower/eye-wash fountain readily available in the immediate work area.

Resistance of Materials for Protective Clothing:

Guidelines for methanol (48):
RECOMMENDED (resistance to breakthrough longer than 8 hours): butyl rubber, Barrier (PE/PA/PE), Tychem(TM) Responder(TM), Trellchem(TM) HPS, Trellchem(TM) VPS, Tychem(TM) SL (Saranex(TM), Tychem(TM) TK.
CAUTION, use for short periods only (resistance to breakthrough within 1 to 4 hours): Neoprene, Viton(TM), Viton(TM)/Butyl rubber, Silver Shield/4H(TM) (polyethylene/ethylene), Tychem(TM) F, Tychem(TM) BR/LV.
NOT RECOMMENDED for use (resistance to breakthrough less than 1 hour): Natural rubber, Neoprene rubber, Nitrile rubber, polyethylene, polyvinyl alcohol, polyvinyl chloride, Tychem(TM) CPF3.

This material is a recognized skin absorption hazard (ACGIH or OSHA).
Recommendations are NOT valid for very thin Natural rubber, Neoprene, Nitrile and PVC gloves (0.3 mm or less).
Resistance of specific materials can vary from product or product. Breakthrough times are obtained under conditions of continuous contact, generally at room temperature. Evaluate resistance under conditions of use and maintain clothing carefully.

Personal Hygiene:

Remove wetted clothing immediately. Keep in closed containers. Launder before rewearing or discard. Inform laundry personnel of hazards. No eating, drinking or smoking in the work area.

EXPOSURE GUIDELINES

THRESHOLD LIMIT VALUES (TLVs) / AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH) / 2010

Time-Weighted Average (TLV-TWA):	200 ppm - Skin
Short-Term Exposure Limit (TLV-STEL):	250 ppm - Skin
TLV Basis - Critical Effect(s):	Headache; Eye damage

TLV Definitions:

"SKIN" NOTATION: Contact with skin, eyes and mucous membranes can contribute to the overall exposure and may invalidate the TLV. Consider measures to prevent absorption by these routes.

TLV Comments:

BIOLOGICAL EXPOSURE INDICES (BEIs): The ACGIH has adopted a BEI for this chemical. BEIs provide an indication of worker exposure by measuring the chemical or its breakdown products in the body or by measuring

biochemical changes resulting from exposure to the chemical. Consult the BEI documentation for further information.

NOTE: In many jurisdictions, exposure limits are similar to the ACGIH TLVs. Since the manner in which exposure limits are established, interpreted, and implemented can vary, obtain detailed information from the appropriate government agency in each jurisdiction.

PERMISSIBLE EXPOSURE LIMITS (PELs) / FINAL RULE LIMITS / US OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA)

Time-Weighted Average (PEL-TWA): 200 ppm - SKIN
Short-Term Exposure Limit (PEL-STEL): 250 ppm - SKIN

Final Rule Limit PEL Comments:

"SKIN" DESIGNATION: Skin contact can contribute to the overall exposure to this chemical. Prevent or reduce skin absorption through the use of gloves, coveralls, goggles or other appropriate personal protective equipment, engineering controls or work practices.

NOTE: The OSHA PEL Final Rule Limits are currently non-enforceable due to a court decision. The OSHA PEL Transitional Limits are now in force.

PERMISSIBLE EXPOSURE LIMITS (PELs) / TRANSITIONAL LIMITS / US OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA)

Time-Weighted Average (PEL-TWA): 200 ppm (260 mg/m3)

Transitional Limit PEL Comments:

These Permissible Exposure Limits are taken from 29 CFR 1910.1000 Table Z - 1.

EMERGENCY RESPONSE PLANNING GUIDELINES (ERPGs) / AMERICAN INDUSTRIAL HYGIENE ASSOCIATION (AIHA) / 2009

ERPG-1: 200 ppm
ERPG-2: 1000 ppm
ERPG-3: 5000 ppm

The ERPG-1 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing other than mild transient adverse health effects or perceiving a clearly defined, objectionable odor.

The ERPG-2 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action.

The ERPG-3 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing or developing life-threatening health effects.

NOTE: Users of the ERPG values are strongly encouraged to consult the documentation before use.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Molecular Weight: 32.04

Conversion Factor:
1 ppm = 1.308 mg/m3; 1 mg/m3 = 0.765 ppm at 25 deg C (calculated)

Physical State:	Liquid
Melting Point:	-97.7 deg C (-143.9 deg F) (37,38)
Boiling Point:	64.7 deg C (148.5 deg F) (34,38)
Decomposition Temperature:	Not available.
Relative Density (Specific Gravity):	0.791 at 20 deg C (38,60); 0.787 at 25 deg C (34,60) (water = 1)
Solubility in Water:	Soluble in all proportions (31,38)
Solubility in Other Liquids:	Soluble in all proportions in ethanol, other alcohols, benzene, chloroform, diethyl ether, other ethers, esters, ketones, and most other organic solvents.(31,38,60)
Coefficient of Oil/Water Distribution (Partition Coefficient):	Log P(oct) = -0.77 (61)
pH Value:	Not available.
Acidity:	Very weak acid and very weak base (41,42)
Dissociation Constant:	pKa = 15 (42); 15.5 (37)
Viscosity-Dynamic:	0.59 mPa.s (0.59 centipoises) at 20 deg C (37) ; 0.54-0.55 mPa.s (0.54-0.55 centipoises) at 25 deg C (34,38)
Viscosity-Kinematic:	0.75 mm2/s (0.75 centistokes) at 20 deg C; 0.686-0.699 mm2/s (0.686-0.699 centistokes) at 25 deg C (calculated)
Saybolt Universal Viscosity:	27.9-28.2 Saybolt Universal Seconds at 37.8 deg C (100 deg F) (calculated)
Surface Tension:	22.5 mN/m (22.5 dynes/cm) at 20 deg C (44); 22.1 mN/m (22.1 dynes/cm) at 25 deg C (31,34)
Vapour Density:	1.1 (air = 1) (calculated)
Vapour Pressure:	12.8 kPa (96 mm Hg) at 20 deg C (40); 16.96 kPa (127.2 mm Hg at 25 deg C (31,37,62)
Saturation Vapour Concentration:	126300 ppm (12.63%) at 20 deg C ; 167400 ppm (16.74%) at 25 deg C (calculated)
Evaporation Rate:	2.1 (37); 4.1 (40) (n-butyl acetate = 1); 5.2 (63); 6.3 (40) (diethyl ether = 1)
Henry's Law Constant:	4.61 x 10(-1) Pa.m3/mol (cited as 4.55 x 10(-6) atm.m3/mol) at 25 deg C (62); log H = -3.73 (dimensionless constant; calculated)

Other Physical Properties:
DIELECTRIC CONSTANT: 33.00 at 20 deg C (38); 32.66 at 25 deg C (34,37)

SECTION 10. STABILITY AND REACTIVITY

Stability:
Normally stable.

Possibility of Hazardous Reactions:

None known.

Incompatibility - Materials to Avoid:

NOTE: Chemical reactions that could result in a hazardous situation (e.g. generation of flammable or toxic chemicals, fire or detonation) are listed here. Many of these reactions can be done safely if specific control measures (e.g. cooling of the reaction) are in place. Although not intended to be complete, an overview of important reactions involving common chemicals is provided to assist in the development of safe work practices.

STRONG OXIDIZING AGENTS (e.g. bromine, chlorine, chromium trioxide, nitric acid, perchlorates or sodium hypochlorite) - may react violently or explosively. Increased risk of fire and explosion.(35,36,45)
HYDROGEN PEROXIDE - concentrated peroxide and methanol can be detonated by shock or heat.(45)
METALS (e.g. powdered aluminum or magnesium) - mixtures can detonate, with more power than military explosives.(45)
CARBON TETRACHLORIDE and METALS (e.g. aluminum, magnesium or zinc) - dissolution of the metals in 9:1 methanol-carbon tetrachloride mixtures is vigorous and potentially hazardous.(45)
ALKALI METALS (e.g. sodium or potassium) - reaction may be explosive due to the formation of hydrogen-air mixtures, unless air is excluded.(32)
ACETYL BROMIDE - reaction is violent, with the evolution of hydrogen bromide.(45)
DICHLOROMETHANE - becomes flammable in air at 27 deg C and 100 kPa (1 bar) pressure in the presence of 0.6 % methanol.(45)
PERCHLORIC ACID or METAL PERCHLORATES (e.g. barium perchlorate or lead perchlorate) - may form shock-sensitive or explosive compounds.(35,36,45)
POTASSIUM TERT-BUTOXIDE - contact with solid butoxide caused ignition after 2 minutes.(45)
ALKYLALUMINUM SOLUTIONS, BERYLLIUM HYDRIDE, CYANURIC CHLORIDE, ISOCYANATES or PHOSPHORUS (III) OXIDE (tetraphosphorus hexaoxide) - may react violently with generation of heat.(35,36,45)
DIETHYL ZINC - reacts explosively, with ignition.(45)
MINERAL ACIDS (e.g. sulfuric acid), ORGANIC ACIDS, ACID ANHYDRIDES, ACID CHLORIDES or SODIUM HYDROXIDE AND CHLOROFORM - reaction may be vigorous or violent, with the evolution of heat.(32,35,36)

Hazardous Decomposition Products:

Decomposes on heating to produce carbon monoxide and formaldehyde.(34)

Conditions to Avoid:

Heat, open flames, static discharge, sparks and other ignition sources.

Corrosivity to Metals:

Methanol is corrosive to type 12L14 carbon steel at room temperature and type 3003 aluminum, copper (10-100% methanol solution) and admiralty brass, at 93 deg C.(64) Methanol is not corrosive to most metals. Methanol is not corrosive (corrosive rates of less than 0.50 mm/year to less than or equal to 0.05 mm/year) at room temperature to stainless steel (e.g. types 301, 304, 316, 321, 347, 400 series and Carpenter 20Cb-3) types 3003 and B-356 aluminum, types 1010, 1020, 1075 and 1095 carbon steel, 3% nickel and ductile cast iron, high nickel (Ni-resist) and high silicon cast iron, nickel and nickel-base alloys, Monel, Hastelloy, Inconel and Incoloy, copper, silicon copper, silicon bronze, brass, admiralty brass, naval brass, naval bronze, bronze, tantalum, titanium and zirconium.(46,64)

Corrosivity to Non-Metals:

Methanol attacks plastics such as nylon 66, nylon 610, acrylonitrile-butadiene-styrene (ABS), styrene-acrylonitrile (SAN), polyurethane (rigid), thermoset isophthalic

polyester and polystyrene (46,65); elastomers, such as polyacrylate, polyurethane, hard rubber, soft rubber and Viton A.(46,66);and general purpose epoxy coating,(46) Methanol does not attack plastics such as Teflon and other fluorocarbons, like ethylene tetrafluoroethylene (EFTE; Tefzel), ethylene chlorotrifluoroethylene (ECTFE; Halar), chlorotrifluoroethylene (CFTE, Kel-F), and polyvinylidene fluoride (PVDF; Kynar), polyvinylidene chloride (Saran), chlorinated polyvinyl chloride (CPVC), polyvinyl chloride (PVC), polypropylene (PP), nylon 11, nylon 12, polyetherether ketone (Peek), terephthalate polyethylene, high density polyethylene (HDPE), ultra high molecular weight polyethylene (UHMPE), crosslinked polyethylene (XPE), polyphenylene oxide (Noryl), thermoset bisphenol A fumarate polyester and thermoset vinyl ester (46,65); elastomers such as nitrile rubber (NBR; nitrile Buna N), ethylene propylene (EP); ethylene propylene diene (EPDM), chloroprene (neoprene), butyl rubber (isobutylene isoprene; IIR), Teflon and other fluorocarbons, Chemraz and Kalrez, styrene-butadiene (SBR), natural rubber, synthetic isoprene, chlorosulfonated polyethylene (CSM; Hypalon), fluorosilicone, silicone, chlorinated polyethylene (CM), flexible polyvinyl chloride (PVC) and low density polyethylene (LDPE) (46,66); and coatings such as coal tar epoxy, chemical resistant epoxy, polyester, urethanes, vinyls and zinc rich.(46)

SECTION 11. TOXICOLOGICAL INFORMATION

Methanol is significantly less toxic to most experimental animals than humans, because most animal species metabolize methanol differently. Several researchers have demonstrated that monkeys have similar susceptibility to the effects of methanol compared to humans.(1,5) Therefore, this review will provide information for studies using monkeys, wherever possible.

LC50 (rat): 64000 ppm (4-hour exposure) (14, unconfirmed)

LD50 (oral, rat): 5628 mg/kg (14, unconfirmed)
LD50 (oral, 14-day old rat): 5850 mg/kg (cited as 7.4 mL/kg) (15)
LD50 (oral, young adult rat): 10280 mg/kg (cited as 13.0 mL/kg) (15)
LD50 (oral, monkey): 3000 mg/kg (1/1 animal died) (16)
NOTE: An oral LD50 (mouse) of 420 mg/kg has been reported (1), but cannot be confirmed in the original paper (18).

LD50 (dermal, rabbit): 15800 mg/kg (cited as 20 mL/kg) (2 citing unpublished information)

Eye Irritation:

Methanol is a moderate eye irritant.

Application of 0.1 mL of undiluted methanol caused moderate injury in rabbits (scored up to 5 where 5 is severe injury; graded 3/10).(19) In another study, application of 100 microlitres of undiluted methanol produced moderate irritation in rabbits (average scores at 24, 48 and 72 hours: redness: 2.06/3; chemosis: 0.72/4; iris injury: 0.61/2; corneal opacity: 0.56/4).(20) In an unpublished study, application of undiluted methanol caused moderate corneal opacity in 3/6 rabbits and redness in the eyes of 6/6 rabbits. A 50% solution caused minimal to no effects and a 25% solution caused no effects.(2, unconfirmed)

Skin Irritation:

Insufficient information was located to draw conclusions about the skin irritancy of methanol.

In an unconfirmed Draize test, application of 20 mg of methanol for 24 hours caused

moderate irritation in rabbits.(21) No scoring information was provided.

Effects of Short-Term (Acute) Exposure:

Many studies have shown that methanol produces central nervous system (CNS) depression following ingestion and inhalation in several animal species. Observations have included incoordination, respiratory depression, unconsciousness, and death. Non- primate species do not ordinarily show symptoms of metabolic acidosis or the visual effects which have been observed in primates and humans.(1,2)

Inhalation:

Monkeys exposed by inhalation to 500, 2000 or 5000 ppm for 4 weeks showed no upper respiratory tract irritation, lung, liver, eye or optic nerve effects.(22) The RD50, the concentration that produces a 50% decrease in the respiratory rate of mice, is 41514 ppm (10 minutes).(23) Exposure to this concentration is expected to produce intolerable eye, nose and throat irritation (sensory irritation) in humans.

Skin Contact:

In a limited study, monkeys were exposed by skin contact to methanol in a way which eliminated inhalation exposure. The lowest dose tested was 1580 mg/kg (395 mg/kg (cited as 0.5 mL/kg) applied 4 times in 1 day), which resulted in death of the exposed animals.(24)

Ingestion:

Studies using monkeys exposed orally to doses of 3000 mg/kg and greater have shown that, in most cases, the animals initially developed moderate CNS depression for 1-2 hours. These symptoms were followed by a period of 8-12 hours where there were no obvious signs of toxicity. Then, progressive deterioration of the animals occurred with vomiting, weakness, coma and death occurring in about 12-33 hours.(25) Eye changes were observed in 2 monkeys orally exposed to lethal doses (3000 or 6000 mg/kg).(16) In other studies, significant eye effects have been produced in monkeys 40-60 hours after oral exposure to 2000 mg/kg and then 500-1000 mg/kg at 12-24 hour intervals.(1) In a study designed to provoke aspiration, aspiration of 0.2 mL methanol resulted in the death of only 1/10 rats. Methanol, like other alcohols, is expected to pose a significant risk of aspiration. In this study, the methanol boiled out of the animals mouth before it could be aspirated.(26)

Effects of Long-Term (Chronic) Exposure:

Inhalation:

No significant effects were observed in monkeys exposed by inhalation to 13, 130 or 1300 mg/m3 for 22 hours/day for 29 months.(1, unconfirmed)

Ingestion:

Repeated oral exposure of monkeys to 3000-6000 mg/kg from 3-20 weeks resulted in minor liver cell changes.(17, unconfirmed)

Skin Sensitization:

In an unpublished study, negative results were obtained in guinea pigs in a modified Magnusson-Kligman maximization test.(1, unconfirmed)

Carcinogenicity:

A well-conducted oral study using rats suggests that methanol may be carcinogenic, but further studies are required before firm conclusions can be drawn. Limited inhalation studies using mice, rats and monkeys have not shown carcinogenicity.

Rats (100/sex/group) were given 0, 500, 5000 or 20000 ppm methanol (99.8% purity) in their drinking water for 104 weeks. Estimated doses are 0, 50, 500 or 2000 mg/kg/day. There was a dose-related increase in total malignant tumours in treated males and females, which was significant at 2000 mg/kg/day. At 2000 mg/kg/day, there were significant increases in carcinomas of the head and neck, testicular tumours and uterine sarcomas. There was also a dose-related increase in bone cancer, lymphoma and leukemia, however statistical significance was not reached.(28) In other studies, mice, rats and monkeys were exposed by inhalation to 10-1000 ppm methanol for 20-22 hours/day for 18-30 months. No evidence of carcinogenicity was found in any species.(1,2) In a skin carcinogenicity study, methanol was used as the solvent control. Mice were exposed to 25 microlitres of methanol twice weekly for 50 weeks. No evidence of carcinogenicity was observed.(1)

Teratogenicity, Embryotoxicity and/or Fetotoxicity:

Methanol has produced fetotoxicity in rats and teratogenicity in mice exposed by inhalation to high concentrations that did not produce significant maternal toxicity.(14,27)

Mice were exposed by inhalation to 1000, 2000, 5000, 7500, 10000, or 15000 ppm on days 6-15 of pregnancy (7 hr/d). No visible signs of maternal toxicity were noted, but 1/30-40 mothers died in each group exposed to 7500 ppm and above. There was a dose-related significant decrease in the number of live pups/litter (post-implantation mortality) at 7500 ppm and above. A significant increase in malformations (e.g. cleft palate, exencephaly, skeletal anomalies) was observed at 5000 ppm and above. Fetal body weights were significantly reduced at 10000 ppm and higher.(27) Rats (15/group) were exposed by inhalation to 0, 5000, 10000 on days 1-19 or 20000 ppm on days 7-15 of pregnancy. Maternal toxicity (slightly unsteady gait during the first few days of exposure) was observed at 20000 ppm only, however there was no effect on body weight. A dose-related significant decrease in fetal weight was observed at 10000 and 20000 ppm. There was a significant increase in the number of litters with skeletal or visceral malformations at 20000 ppm.(14) This study is limited by the relatively small number of animals/group. Female monkeys (11-12/concentration in a 2-cohort design) were exposed to 0, 200, 600 or 1800 ppm vapour for approximately 120 days prior to breeding, during breeding (3 days to 8 months) and through the pregnancy (2.5 hr/d, 7 d/wk). There were no effects on maternal weight gain and no clinical signs of toxicity. There was a non-significant increase in pregnancy complications, which necessitated delivery by caesarian in exposed animals. There was also a significant decrease in the length of pregnancy in exposed animals. The decrease may have indicated an effect on the fetal neuroendocrine system. A hydrocephalic fetus occurred in one animal exposed to 1800 ppm. There were no effects on birth weight, health of the offspring or the number of live births. The offspring were followed for more than 1 year after birth. No effects were seen on most aspects of neurobehavioural development. There was a concentration-related association between methanol exposure and a delay in early sensorimotor development in male infants. Methanol exposure was also associated with deficits in recognition memory. However, these effects were not dose-related and there were a small number of animals/group making it difficult to draw conclusions. At 12 and 17 months of age, 2/7 female infants in the 1800 ppm group developed a severe wasting syndrome, the cause of which could not be determined.(3,12,29) Other studies located are limited by the small number of animals/group.

Reproductive Toxicity:

The information located does not suggest that methanol is a reproductive toxin.

No effects on reproductive performance were reported in a two-generation study. Rats were administered 10-1000 ppm by inhalation for 18-20 hours/day.(1) Female monkeys (11-12/concentration in a 2-cohort design) were exposed to 0, 200, 600 or 1800 ppm vapour for approximately 120 days prior to breeding, during breeding (3 days to 8 months) and through the pregnancy (2.5 hr/d, 7 d/wk). The exposures did not alter the menstrual cycles, the number of breedings before conception or the conception rate.(29) Some studies suggest that inhalation of methanol may affect certain hormones (e.g. testosterone and luteinizing hormone) in male rats. The results have not been consistent or dose-related.(1,2,5)

Mutagenicity:

There is insufficient information available to conclude that methanol is mutagenic. A positive result was obtained in a limited oral study in mice, however other oral and inhalation studies in live rats and mice have given negative results. Mostly negative results have been obtained in cultured mammalian cells, bacteria and fruit flies (Drosophila).
Oral administration of 1000 mg/kg increased the incidence of chromosomal aberrations, as well as the incidence of micronuclei in red blood cells in mice.(30) This study is reported in an abstract form and there are not enough details available to draw firm conclusions. Negative results (micronuclei, chromosomal aberrations, sister chromatid exchanges) were obtained in other studies where live mice or rats were exposed orally or by inhalation.(1,2,50,51)
Negative results (sister chromatid exchanges, micronucleus) were obtained in cultured mammalian cells, without metabolic activation.(1,2,50,52) A positive result (gene mutation) was obtained in cultured mammalian cells, with metabolic activation.(53)
Negative results (DNA repair, gene mutation) were obtained in tests using bacteria, with or without metabolic activation.(1,2,50) A positive result (gene mutation) was obtained in a test using bacteria, without metabolic activation.(50) Inconclusive results were obtained in one strain of bacteria, in the presence of metabolic activation.(2)
A negative result (sex-linked recessive mutations) was obtained in fruit flies (Drosophila).(50)

SECTION 12. ECOLOGICAL INFORMATION

NOTE : Inclusion of Ecological Information on an MSDS is optional under the US Hazard Communication Standard and the Canadian Controlled Products Regulations (WHMIS). In other jurisdictions, inclusion of Ecological Information may be a requirement. For specific requirements, contact the relevant regulatory authorities in the jurisdiction where the MSDS is intended to be used.

The American National Standard for Hazardous Industrial Chemicals - Material Safety Data Sheets - Preparation (ANSI Z400.1-2004) provides advice on data that could be included in this section.

Databases in CCOHS's CD-ROM and Web collection which contain useful Ecological Information include CESARS, HSDB® (Hazardous Substances Data Bank) and CHRIS (Chemical Hazards Response Information System).

SECTION 13. DISPOSAL CONSIDERATIONS

Review federal, provincial and local government requirements prior to disposal.
Store material for disposal as indicated in Storage Conditions.
Disposal by controlled incineration or by secure landfill may be acceptable.

SECTION 14. TRANSPORT INFORMATION

CANADIAN TRANSPORTATION OF DANGEROUS GOODS (TDG) SHIPPING INFORMATION

Shipping Name and Description: METHANOL
UN Number: UN1230

Class:	3, 6.1
Packing Group/Category:	II
Special Provisions:	43
Passenger Carrying Road/Railway Vehicle Index:	1 kg or L
Marine Pollutant:	---

NOTE: This information incorporates the Transportation of Dangerous Goods Regulations SOR/2001-286, effective October 14, 2009.

US DEPARTMENT OF TRANSPORT (DOT) HAZARDOUS MATERIALS SHIPPING INFORMATION (49 CFR)

Shipping Name and Description:	METHANOL
Hazard Class or Division:	3
Identification Number:	UN1230
Packing Group:	II

NOTE: This information was taken from the US Code of Federal Regulations Title 49 - Transportation and is effective July 1, 2009.

SECTION 15. REGULATORY INFORMATION

CANADIAN WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM (WHMIS)

CCOHS WHMIS Classification:

B2 - Flammable and combustible material - Flammable liquid
D1B - Poisonous and infectious material - Immediate and serious effects - Toxic
D2A - Poisonous and infectious material - Other effects - Very toxic
D2B - Poisonous and infectious material - Other effects - Toxic

WHMIS Health Effects Criteria Met by this Chemical:

D1B - TDG class 6.1 packing group unknown - toxic - immediate
D2A - Teratogenicity and embryotoxicity - very toxic - other
D2B - Eye irritation - toxic - other

WHMIS Ingredient Disclosure List:

Included for disclosure at 1% or greater. Meets criteria for disclosure at 0.1%.

Detailed WHMIS Classification According to Criteria:

Class A - Compressed Gas:

Does not meet criteria.

Class B - Flammable and Combustible Material:

Meets criteria for "Flammable liquid".
Closed cup flash point: 11 deg C (52 deg F).

Class C - Oxidizing Material:

Does not meet criteria.

Class D - Poisonous and Infectious Material. Division 1 - Immediate and Serious Toxic Effects:

Meets criteria for "Toxic material".

Acute Lethality:

Does not meet criteria.
LC50 (rat): 64000 ppm (4-hour exposure); LD50 (oral, rat): 5628 mg/kg; LD50 (dermal, rabbit): 15800 mg/kg. (Note: Humans are more susceptible to the effects of methanol than experimental animals.)

Transportation of Dangerous Goods (TDG):

"Toxic"; class 6.1, packing group unknown.

Class D - Poisonous and Infectious Material. Division 2 - Other Toxic Effects:

Meets criteria for both "Very toxic material" and "Toxic material".
See detailed evaluation below.

Chronic Health Effects:

Does not meet criteria.
No significant effects in humans or monkeys at low exposures.

Carcinogenicity:

Does not meet criteria. Not included in standard reference lists.
Limited animal information available suggests that methanol is not carcinogenic.

Teratogenicity and Embryotoxicity:

"Very toxic".
Fetotoxic and teratogenic effects observed in animals at concentrations that did not produce maternal toxicity.

Reproductive Toxicity:

Does not meet criteria.
The animal information located does not suggest that methanol is a reproductive toxin.

Mutagenicity:

Does not meet criteria.
In animal studies, a positive result was obtained in a limited oral study using mice. However, other oral and inhalation studies using rats and mice have given negative results.

Respiratory Tract Sensitization:

Does not meet criteria.
Not reported as human respiratory sensitizer.

Skin Irritation:

Insufficient information.
An unconfirmed animal test showed moderate irritation following prolonged (24-hour) exposure. In general, primary alcohols are not skin irritants.

Eye Irritation:

"Toxic".

Moderate irritation observed in animal tests.

Skin Sensitization:

Does not meet criteria.
Only limited human information was located. Negative results were obtained in one unconfirmed test using guinea pigs.

Class E - Corrosive Material:

Does not meet criteria.
Not corrosive to animal skin, type 1020 carbon steel and aluminum alloys.

Class F - Dangerously Reactive Material:

Does not meet criteria.

US OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) HAZARD COMMUNICATION STANDARD (29 CFR 1910.1200)

OSHA Hazard Communication Evaluation:

Meets criteria for hazardous material, as defined by 29 CFR 1910.1200.

EUROPEAN UNION (EU) CLASSIFICATION AND LABELLING INFORMATION

This EU classification information reflects the 29th Adaptation to Technical Progress (ATP) of Council Directive 67/548/EEC. The EU has adopted the 30th ATP (2008/58/EC of 21 August 2008) and 31st ATP (2009/2/EC of 15 January 2009) of this Council Directive. See: http://ecb.jrc.ec.europa.eu/esis for current information.

EU Classification:

Highly flammable. Highly flammable. [F; R11] Toxic: Toxic by inhalation, in contact with skin, and if swallowed. Toxic; Danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed. [T; R23/24/25-39/23/24/25] (49)

EU Risk Phrases:

Highly flammable. Toxic by inhalation, in contact with skin, and if swallowed. Toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed. [R:11-23/24/25-39/23/24/25]

EU Safety Phrases:

Keep locked up and out of the reach of children.* Keep container tightly closed. Keep away from sources of ignition - No smoking. Wear suitable protective clothing and gloves. In case of accident or if you feel unwell, seek medical advice immediately (show label where possible). [S:(1/2-)*7-16-36/37-45]
*This safety phrase can be omitted from the label when the substance or preparation is sold for industrial use only.

EU Comments:

CONCENTRATION GREATER THAN OR EQUAL TO 20%: Toxic. Toxic by inhalation, in contact with skin, and if swallowed. Toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed. [T;R:23/24/25-39/23/24/25]
CONCENTRATION GREATER THAN OR EQUAL TO 10% AND LESS THAN 20%: Toxic. Harmful by inhalation, in contact with skin and if swallowed.

Toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed. [T;R:20/21/22-39/23/24/25]
CONCENTRATION GREATER THAN OR EQUAL TO 3% AND LESS THAN 10%: Harmful. Harmful by inhalation, in contact with skin and if swallowed. Harmful: possible risk of irreversible effects through inhalation, in contact with skin and if swallowed. [Xn;R:20/21/22-68/20/21/22]

Safety phrases relate to the highest concentration division indicated, but may also be applicable to lower concentrations.

SECTION 16. OTHER INFORMATION

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www.ccohs.ca E-mail: clientservices@ccohs.ca Fax: (905) 572-2206 Phone: (905) 572-2981
Mail: 135 Hunter Street East, Hamilton Ontario L8N 1M5