METHANOL INSTITUTE

METHANOL SAFE HANDLING MANUAL – *HEALTH AND SAFETY MODULE*

4TH EDITION

This section describes the toxicological properties of methanol; routes and symptoms of exposure; and effective control strategies, safety precautions, and first aid measures.

1.1 EXPOSURE TO METHANOL

1.1.1 ROUTINE SOURCES OF EXPOSURE

Humans are exposed to methanol from many sources. Not only does methanol occur naturally in the human body, but humans are exposed routinely to methanol through air, water, and food. Food is the primary source of exposure for the general population. It is generally believed that dietary sources contribute to the observed background blood methanol concentrations. Methanol is widely found in small concentrations in the human diet from fresh fruits, vegetables, commercial beverages like fruit juices, beers, wines, and distilled spirits. The food additives Aspartame (an artificial sweetener) and Dimethyl Dicarbonate (DMDC) (a yeast inhibitor used in tea beverages, sports drinks, fruit or juice sparklers), as well as wines, release small amounts of methanol when metabolized in the human body. Table 1 illustrates examples of methanol levels in common foods and beverages, compared to background levels in the human body.

Table 1. Methanol Levels in Foods and Beverages and in Blood

SAMPLE	METHANOL LEVEL
Fresh and canned fruit juices (orange and grapefruit juices)	1-640 mg/l (average of 140 mg/l)
Beer	6-27 mg/l
Wines	96-329 mg/l
Beans	1.5-7.9 mg/kg
Lentils	4.4 mg/kg
Carbonated beverages	~56 mg/l
Human body background level	0.5 mg/kg (0.73 mg/l in blood)

Non-dietary potential exposure to methanol (primarily through inhalation) can result from using certain consumer products, such as paints, windshield washer fluids, antifreeze, de-icers, and adhesives that contain methanol as a solvent. Methanol is also used in fuel cells that power consumer electronic devices such as laptop computers and cellular phones. Fuel cell-powered vehicles may also use methanol as a hydrogen carrier fuel. These relatively new uses of methanol may become more common in the future.

Studies have shown that the U.S. general population has a background blood methanol concentration of between .025 to 4.7 mg/L in blood (milligrams per liter in blood). In controlled studies, humans breathing air containing 200 ppm (parts per million) methanol had blood levels below 10 mg/L.

Most routine environmental exposures to methanol vapor in the air are significantly below occupational exposures. Typical environmental exposures to methanol in the air in rural areas are below 0.0008 ppm and approaching 0.03 ppm in urban areas. Methanol is currently used to a limited extent as an alternative fuel, primarily in a mix of 85% methanol and 15% gasoline, otherwise known as M85. Methanol's proposed use as a substitute for petroleum fuels may result in greater environmental releases to the air through vehicle emissions and at fueling stations.

Occupational (workplace) exposure is likely to cause the highest daily exposure to methanol. Occupational exposures typically occur through inhalation of methanol vapors during production or use. About 70% of the methanol produced in the United States is used as feedstock for the production of other organic chemicals and a variety of consumer products, including windshield washer fluid. It is also used in the treatment of wastewater and sewage. Occupational exposure to methanol may occur during its production, or result from its presence in refrigeration systems and as a component in the production of formaldehyde, MTBE, acetic acid, and other industrial chemicals. The Occupational Safety and Health Administration (OSHA) Time-Weighted-Average (TWA) Permissible Exposure Limit (PEL) to methanol is 200 ppm for an 8-hour day and 40-hour week.

Concentrations of methanol vapors measured in the breathing zone of workers during refueling of methanol-powered transit buses are generally less than 10 ppm. Concentrations of methanol vapors measured in the breathing zone of mechanics changing fuel filters (2-minute procedure) for these buses averaged approximately 50 ppm.

1.1.2 ACCIDENTAL SOURCES OF EXPOSURE

Less common scenarios that are part of general population exposures include the use of methanol-containing fuels as solvents and accidental spillage. Another type of potential accidental exposure to methanol warrants mention. Each year, several thousand cases of accidental ingestion of gasoline are reported to United States poison control centers. Analysis of the data found that 39% of accidental ingestions involve teenage and young adult males, and 36% involved children under 6 years old. Almost all of the former cases occurred during the course of (mouth) siphoning to transfer fuel from one container to another. Most of the latter cases occurred when the children found a used beverage container in which gasoline was stored. With gasoline, the primary toxicity hazard lies in the possibility of regurgitating the fuel and aspirating the vomitus, which can induce chemical pneumonitis. However, if M85 were substituted for gasoline in these situations, methanol would considerably increase the potential for serious morbidity or mortality. Skin contact with methanol solutions can also lead to rapid absorption and appearance of signs of toxicity. Cases of methanol poisoning in children exposed dermally have been reported.

The following table illustrates some of the potential methanol exposure routes and the added methanol body burden expected from the exposure for a 154 lb (70 kg) person.

Table 2. Added Body Burden of Methanol [32]

EXPOSURE/DOSE	ADDED BODY BURDEN OF METHANOL
Background body burden in huamns	35 mg*
Skin contact of hand in liquid methanol, 2 min	170 mg
Inhalation, 40 ppm methanol for 8 hr	170 mg
Inhalation, 150 ppm for 15 min	42 mg**
Inhalation, Ingestion of 12 oz (0.34 liter) of Aspartame sweetened diet beverge	21 mg
Ingestion of 0.2 ml of methanol	170 mg
Ingestion, 0.7-3 oz (25-90 ml) of methanol	Lethal (~21000-70000 mg)

*Estimated from methanol body burden of 0.5 mg/kg body weight for a 70 kg person

**Assuming 100% absorption in lung (60%-85% more likely)

1.1.3 ROUTES OF EXPOSURE

Methanol's primary routes of entry into the body are by inhalation, absorption through the skin as a result of contact, eye contact, and ingestion by either eating or drinking.

1.1.4 METHANOL METABOLISM

Methanol is easily and rapidly absorbed by all routes of exposure and distributes rapidly throughout the body. Humans absorb 60%-85% of methanol that is inhaled. A small amount is excreted by the lungs and kidneys without being metabolized. The rate of metabolism for methanol in the body is 25 mg/kg-hr, which is seven times slower than for ethanol and is independent of concentrations in the blood. Humans metabolize methanol into formaldehyde as the first step. The formaldehyde is then converted to formate (which can be toxic at high concentrations) and finally, to carbon dioxide and water. The half-life of methanol elimination in expired air after oral or dermal exposure is 1.5 hours. Due to their limited capability to metabolize formate to carbon dioxide, humans accumulate formate in their bodies from high-dose methanol exposure. If formate generation continues at a rate that exceeds its rate of metabolism, methanol toxicity sets in. Background levels of methanol in the human body will not result in formate accumulation or adverse health effects. Studies have shown that short-term inhalation exposure to 200 ppm methanol results in blood methanol concentrations of less than (10 mg/l) with no observed increase in blood formate concentration.

Human metabolism of methanol:

$$\text{Methanol} \xrightarrow{\textbf{Step 1}} \text{Formaldehyde} \xrightarrow{\textbf{Step 2}} \text{Formate} \xrightarrow{\textbf{Step 3}} CO_2 + H_2O$$

1.1.5 EFFECTS OF EXPOSURE

Methanol is a poison. This means that it can cause severe and sometimes fatal acute toxic effects from a single exposure. Therefore, the principal concern is with acute exposure through any primary route of entry. The signs and symptoms of methanol exposure do not occur immediately. The time lag between exposure and onset of symptoms may cause misdiagnosis of the cause, particularly in persons who are unaware they have been exposed, or who are unaware of the toxic nature of methanol and the differences between methanol, ethanol, and isopropyl alcohol.

1.1.5.1 GENERAL SYMPTOMS

Regardless of the route of exposure, the toxicity of methanol is the same. Signs of systemic toxic effects may be delayed between 8 and 36 hours after initial exposure. Methanol is irritating to the eyes, the skin, and the respiratory tract. It also strips the natural oils and fat from the skin, causing skin to become dry and cracked. It can cause permanent damage to the optic nerve and central and peripheral nervous system with just a single acute exposure. Other signs and symptoms of methanol poisoning include headache, dizziness, vomiting, severe abdominal pain, back pain, difficulty breathing, cold extremities, lethargy, and lack of coordination. Eye exposure can also cause a burning sensation accompanied by tearing, redness, and swelling. Direct contact with the liquid may cause conjunctivitis and corneal burns. High exposures may result in blindness, organ failure and death.

1.1.5.2 ACUTE EFFECTS

The effects of acute, high-dose methanol exposure have been well characterized in human cases of alcohol poisoning and in animal studies. Generally, the affected individual experiences a short period of intoxication with a mild depression of the central nervous system, followed by a period in which no symptoms of intoxication or toxicity are noted (commonly 12 to 14 hours). This is followed by physical symptoms of poisoning, such as headache, nausea, vomiting, loss of equilibrium, severe abdominal pain, and difficulty in breathing. These symptoms can be followed by coma and death. Other hallmarks of acute methanol toxicity are disturbances of the visual system and accumulation of acid in the body. Methanol exposure results in vision effects that range from excessive sensitivity to light, to misty or blurred vision, to dramatically reduced visual acuity and total blindness.

The amount of methanol that can cause severe methanol exposure is very small: Assuming that 100% methanol fuel is swallowed, the lethal dose is less than one teaspoonful (4 ml) for a one-year old infant, one and one half teaspoons (6 ml) for a 3-year-old child, and less than one ¼ of a cup (10-30 ml) for an adult.

1.1.5.3 CHRONIC EFFECTS

In contrast to the effects of acute, high-concentration exposure, relatively little is known about the effects of chronic, low-dose methanol exposure. Based on the limited number of case reports and epidemiological studies, the effects of prolonged exposures to methanol are similar to those of acute exposure: visual and central nervous system disorders. Repeated direct skin contact with methanol can cause dermatitis with dryness and cracking. Other symptoms of chronic exposure include eye irritation, headache, giddiness, insomnia, gastrointestinal problems, and especially visual difficulties.

According to the Organization for Economic Cooperation and Development's (OECD's) Screening Information Data Set, methanol is a candidate for further work on human health effects due to potential hazardous properties, including neurological effects, central nervous system (CNS) depression, ocular effects, reproductive and developmental effects, and other organ toxicity. Rapid metabolism and excretion are noted depending on the dose.

Methanol is not currently listed by any international consensus body or government agency (e.g., IARC, NTP, NIOSH, ACGIH, or OSHA) as being a carcinogen. EPA's Integrated Risk Information System (IRIS) is conducting a human health hazard and dose-response assessment of methanol. A draft IRIS Toxicological Review of Methanol released for external peer review in December 2009 concluded that the weight of evidence is consistent with a determination that methanol is likely to be carcinogenic to humans. This is defined as "an agent that has tested positive in animal experiments in more than one species, sex, strain, site, or exposure route, with or without evidence of carcinogenicity in humans." In March 2011, EPA placed the external peer review of the draft IRIS Methanol Toxicological Review on hold, following a report from the National Toxicology Program (NTP), which recommended a review to resolve differences of opinion in the diagnoses of certain tumors reported in a methanol research study completed by a European research institute. EPA and the National Institute of Environmental Health Sciences plan to jointly sponsor an independent Pathology Working Group (PWG) review of select studies conducted at the Institute.

According to the draft IRIS Toxicological Review, “there is no information available in the literature regarding the observation of cancer in humans following chronic administration of methanol.” Likewise, there are no human data that demonstrate a link between methanol exposure and an increased incidence of birth defects or reproductive hazards. However, available data on mice and rats indicates that inhalation or oral exposure to methanol at high doses is a developmental hazard. Since mice and rats metabolize methanol differently than humans, there is uncertainty as to the predictive value of these studies to human health effects. In 2012, the State of California added methanol to a list of chemicals known to the State to cause reproductive toxicity under its Proposition 65.

There is concern for adverse developmental effects in fetuses if pregnant women are exposed to methanol at levels that result in high blood methanol concentrations greater than 10 mg/l. Blood methanol levels of 10 mg/l or greater are not expected to result from normal methanol PEL. However, this value is not intended to represent the highest “safe” blood concentration.

1.2 EXPOSURE CONTROL

1.2.1 ENGINEERING CONTROLS

Where possible, automatically pump liquid methanol from drums or other storage containers to process containers to minimize the potential for exposure. Methanol should always be kept within closed systems and not left open to the atmosphere. Refer to Sections 3.2 (Methanol Storage) and Chapter 5 (Managing Methanol Safely: Process Safety) for more information.

1.2.1.1 VENTILATION

The building ventilation system should provide fresh air for normal operation and should take into consideration the possibility of a leak. In some cases, natural ventilation may be adequate; otherwise, mechanical ventilation systems should be provided. Ventilation requirements should be determined on a site-specific basis, but the ultimate target is to ensure that methanol concentrations in air do not reach or exceed 200 ppm.

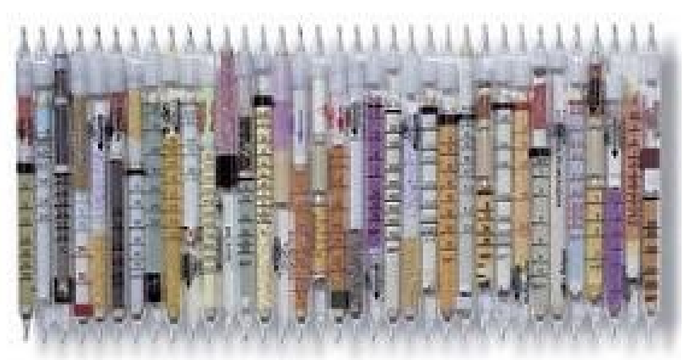
When possible, enclose operations and use proper local exhaust ventilation at the site of methanol transfer, use, or release. The type of ventilation will depend on factors such as dead air spaces, temperature of the methanol process, convection currents, and wind direction. These factors must be considered when determining equipment location, type, and capacity. If mechanical ventilation is installed, spark-proof fans must be used.

1.2.2 EXPOSURE MONITORING

Methanol has a faintly sweet alcohol odor but does not make its presence known until a concentration of 2000 ppm or above is reached, which is ten times higher than the safe limit for human exposure of 200 ppm. Because the odor of methanol is a poor indicator of concentration, it is essential that some quantitative measure of exposure be determined. This is necessary to ensure that the health of workers is not impaired and to determine compliance with any applicable regulations.

Methanol vapor concentrations can be measured using direct-reading gas detection tubes, such as colorimetric detection tubes, or with electronic instruments, such as portable gas monitors. Gas monitors can provide continuous readings of methanol concentrations, and alarms can also be set at specified concentrations. TWA personal exposure concentrations can also be measured using an air sampling pump with silica gel sorbent tubes.

Portable Gas Monitor



Gas Detection Tubes

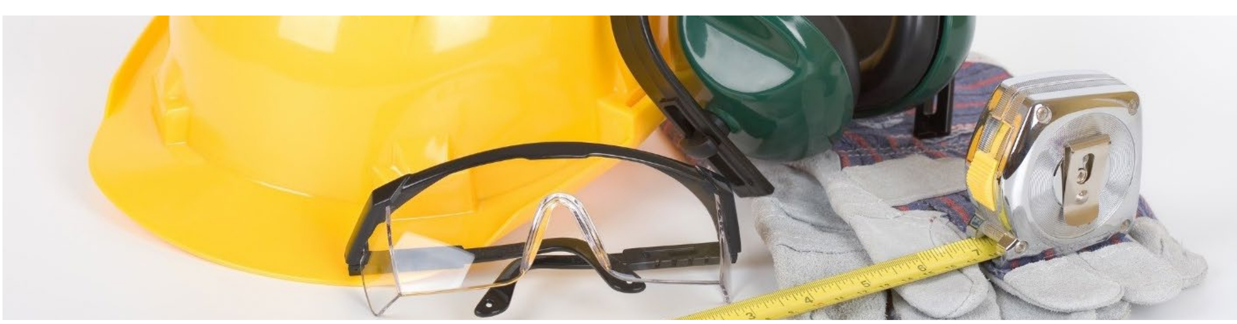
(Courtesy of Drägerwerk AG with permission)

Currently, the OSHA PEL and the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) for methanol are set at 200 ppm [3]. Both values are based on an 8-hour TWA exposure. The ACGIH short-term exposure limit for methanol is 250 ppm, and it contains a skin notation. The National Institute for Occupational Safety and Health (NIOSH) has also set the 10-hour TWA recommended exposure limit at 200 ppm. The OSHA PELs are set to protect workers against the health effects of exposure to hazardous substances, such as methanol. PELs are regulatory limits on the amount or concentration of a substance in air that is not to be exceeded in the workplace. They may also contain a skin designation, which serves as a warning that skin absorption should be prevented in order to avoid exceeding the absorbed dose received by inhalation at the PEL level. The ACGIH TLVs are guidelines used by industrial hygienists and other health and safety professionals in making decisions regarding safe levels of exposure to various chemicals found in the workplace. Both the PEL and the TLV are maximum levels of exposure that the typical worker can experience without adverse health effects.

ACGIH also publishes Biological Exposure Indices (BEI) for a number of chemicals. BEI determinants are an index of an individual's "uptake" of a chemical. Most BEIs are based on a direct correlation with the TLV, although some relate directly to an adverse health effect. The BEI for methanol in urine collected at the end of the shift is 15 mg/l.

1.2.3 PERSONAL PROTECTIVE EQUIPMENT

Exposure to methanol can occur via inhalation, skin absorption, contact with the eyes, or ingestion, whenever methanol is used or handled. The level of risk of exposure to methanol will dictate the appropriate level of personal protective equipment required. At a minimum, safety glasses with side shields or safety goggles and task-appropriate gloves are recommended. Depending on the situation, additional personal protective equipment may be required.



1.2.4 RESPIRATORY PROTECTION

Respiratory protection should be selected based on hazards present and the likelihood of potential exposure. Air purifying respirators with organic vapor (OVA) cartridges are not appropriate protection against methanol vapors due to the very short service life of the OVA cartridge. In addition, the odor threshold of methanol can vary between 100 and 1500 ppm, so the OVA cartridge may not provide an adequate warning of when breakthrough of methanol vapors occurs and the respirator is no longer providing protection from methanol exposure. The use of a supplied air respirator with a full face piece operate in a pressure-demand or other positive-pressure mode is the recommended respiratory protection. Evaluation of the appropriate type of respirator should also factor in the need for eye protection. Fit testing and regular maintenance programs for respiratory equipment are required whenever use of respiratory protection is required for a specific job task. The following table is a guide for whether respiratory protection is required or not, when the air concentration of methanol is known.

Table 3. Respiratory Protection Guide

AIR CONCENTRATION OF METHANOL	RESPIRATORY PROTECTION
<200 ppm	No protection required. Skin and eye protection may still be needed.
200 ppm or greater	Protection required if the daily time-weighted-average (TWA) exposure is exceeded or if there are additional routes of exposure (skin, eyes, ingestion). A supplied air system must be used if protection is needed.
>200 ppm sustained	A supplied air breathing apparatus (SCBA) system must be used (i.e., positive-pressure SBCA).

1.2.5 CHEMICAL-RESISTANT CLOTHING/MATERIALS

Chemical-resistant clothing/materials should be worn if repeated or prolonged skin contact with methanol is expected. These may include rubber boots, resistant gloves, and other impervious and resistant clothing. Chemical-resistant materials include butyl rubber and nitrile rubber. Use chemical goggles when there is a potential for eye contact with methanol, including vapor. A full face-shield may be worn over goggles for additional protection, but not as a substitute for goggles.

Table 4 serves as guidance for proper personal protective equipment, depending on the situation presented.

Table 4. Personal Protective Equipment Selection

LOW RISK OF VAPOR/ LOW RISK OF VOLUME SPLASH	HIGH RISK OF VAPOR/ LOW RISK OF VOLUME SPLASH	HIGH RISK OF VAPOR/ HIGH RISK OF VOLUME SPLASH
Fire retardant clothing	Full chemical resistant suit	Full chemical resistant, impermeable suit
Gloves (Silvershield or disposable nitrile)	Chemical-resistant rubber gloves	Checmical-resistant rubber gloves
Safety glasses with side shields	Full face supplied air respirator	SCBA or compressed air breathing apparatus (CABA)
Full boot cover	Chemical-resistant rubber boots	Chemical-resistant rubber boots

1.3 SAFETY PRECAUTIONS

1.3.1 ROUTINE OPERATIONS

Due to the flammability of methanol vapor, static electricity may ignite it. Therefore, grounding and bonding should always be applied when there is a potential for static electricity, and is required for all equipment. Carbide-tipped clamps (to ensure good contact through paint) and dip tube filling are generally used to guard against ignition from static electricity.

The following is a recommended list of additional safety precautions to take. Special or high-hazard operations may require additional precautions and are addressed in the next section.

- Smoking must be prohibited.
- Vehicle access should be strictly controlled.
- Ventilation must be sufficient to cope with the maximum expected vapor levels in buildings.
- Positive pressure may be required for methanol-free areas, such as control, switch and smoking rooms.
- Storage tank vents to atmosphere should be sized for fire-heated emergency vapor release.
- Electrical equipment must be explosion-proof to meet national electrical code requirements.
- Alcohol-resistant Aqueous Film-forming Foam (AR-AFFF) with 6% foam proportioning (with water) equipment is advised for use on methanol fires.
- Dry chemical extinguishers should be accessible for small fires. An adequate supply of handheld and wheeled types should be available.
- Hydrants should be strategically placed with adequate hoses.
- Small spills should be remediated with sand, earth, or other non-combustible absorbent material, and the area then flushed with water. Larger spills should be diluted with water and diked for later disposal.
- Lighting should be grounded. Tall vessels and structures should be fitted with lightning conductors that are securely grounded.

1.3.2 SPECIAL OR HIGH HAZARD OPERATIONS

1.3.2.1 CONFINED SPACE ENTRY

Many workplaces contain spaces that are “confined” because they hinder the activities of workers who must enter, work in, and exit them. A confined space has limited or restricted means for entry or exit, and it is not designed for continuous occupancy by workers. Examples of confined spaces include, but are not limited to, underground vaults, tanks, storage bins, manholes, pits, silos, process vessels, and pipelines. In addition, confined spaces often contain an atmosphere that is oxygen-deficient, toxic, or combustible, therefore requiring them to be classified by OSHA as “permit-required” for entry. Deaths in confined spaces have occurred in the workplace because the atmosphere within the confined space was not tested prior to entry and/or continually monitored. *Confined space entry procedures must comply with all applicable Federal and local codes and regulations.*

In addition to the potential for an oxygen-deficient atmosphere, accumulation of methanol vapors in confined spaces may lead to explosion if ignited. The Lower Explosive Limit (LEL) of methanol is 6% (60000 ppm) by volume, which is 10 times the Immediately Dangerous to Life or Health (IDLH) concentration, and the Upper Explosive Limit (UEL) is 36% (360000 ppm) by volume. At concentrations in air below the LEL, there is not enough methanol vapor to spread a flame. At concentrations in air above the UEL, there is too much methanol and not enough oxygen to spread a flame. The LEL and UEL of methanol correspond to a temperature range of 54°F to 106°F (12°C to 41°C). In this temperature range, methanol will burn. Since methanol vapor concentrations in the explosive range are toxic, keeping the air concentration safe for health also makes it safe from fire. However, keeping it safe from fire does not necessarily make it safe to breathe.

In confined spaces, ventilation systems may be necessary in order to keep airborne concentrations of methanol below the LEL and below permissible exposure limits. Before entering a confined space where methanol may be present, check to make sure that an explosive concentration does not exist.

1.3.2.2 HOT WORK

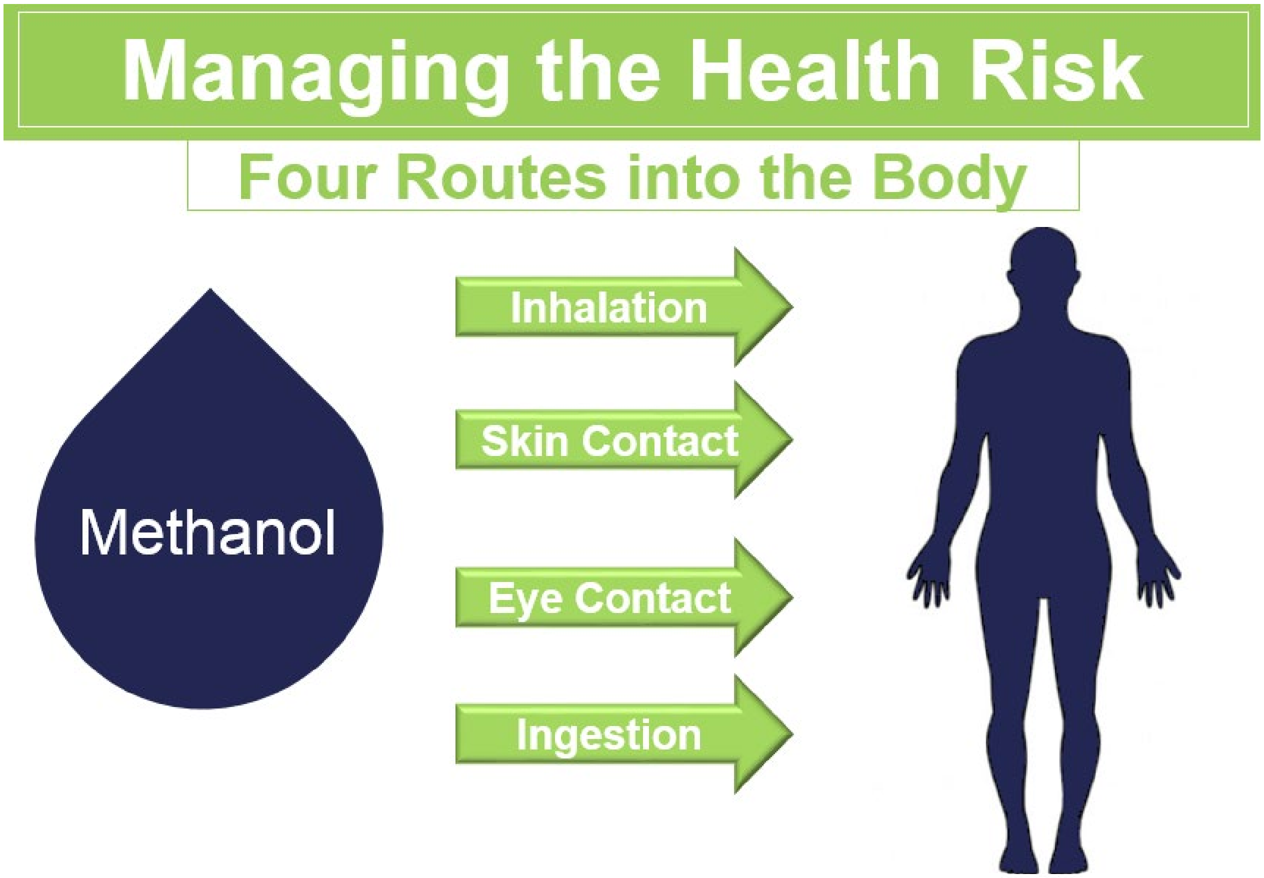
Hot work is any activity that creates heat, flame, sparks, or smoke. Examples of hot work include, but are not limited to, welding, brazing, soldering, cutting, heat treating, grinding, and using power-actuated tools. Methanol is extremely flammable and has the potential to catch fire when hot work is performed near methanol sources.

Methanol is defined by the NFPA and OSHA as a Class 1B flammable liquid, or by the United Nations as a flammable liquid (UN Hazard Class 3). It releases vapors at or below ambient temperatures. When mixed with air, methanol can burn in the open. The specific gravity of unmixed methanol vapor is 1.1 compared to air at 1.0. Methanol vapors are marginally heavier than air and may travel short distances (yards or meters) along the ground before reaching a point of ignition and flashing back. The distance of travel depends on circumstances of release. Turbulent release promotes rapid mixing with air; non-turbulent release retards mixing with air.

Pure methanol has a low flash point of 54°F (11°C) and a wide flammability range (5.5-36.5 vol%). Flash point is defined as the minimum temperature at which the vapor pressure of a liquid is sufficient to form an ignitable mixture with air near the surface of the liquid. Flammability range is the concentration range within which a mixture of air and methanol vapor is capable of igniting, providing availability of an ignition source. The extent of the flammability range means that methanol vapor can be ignited throughout a wide range of concentrations in air [33]. The minimum ignition energy (MIE) for methanol in air is slightly lower than that of gasoline. Local hot spots can exceed the flash point and methanol can be ignited. When methanol catches fire, it burns with a clear blue flame that is very difficult to see in bright sunlight. Methanol may be on fire and you may not be able to discern the hazard of a fire by looking for a flame.

The hazards associated with hot work can be reduced by implementing an effective hot work program that includes prior work authorization, safe welding practices, and a fire watch.

1.4 FIRST AID MEASURES



First aid is the immediate temporary treatment given to an exposed individual before the services or recommendations of a medical professional are obtained. Prompt action is essential. If necessary, medical assistance must be obtained as soon as possible. A Material Safety Data Sheet (SDS) for methanol or materials containing methanol should be carefully reviewed for information on first aid measures.

1.4.1 INHALATION

In case of inhalation of methanol vapors, first remove the individual to fresh air if it is safe for you to do so, and keep him or her warm and at rest. Monitor for respiratory distress. If difficulty in breathing develops or if breathing has stopped, administer artificial respiration or cardiopulmonary resuscitation (CPR) immediately and seek medical attention. If trained to do so, administer supplemental oxygen with assisted ventilation, as required.

1.4.2 SKIN CONTACT

In case of contact with skin, immediately use an emergency eyewash or safety shower, and flush the exposed area with copious amounts of tepid water for at least 15 minutes. Contaminated clothing and shoes should be removed under the shower. Wash the area thoroughly with soap and water. Seek medical attention if irritation or pain persists or if symptoms of toxicity develop. Wash contaminated clothing and shoes before reuse.

1.4.3 EYE CONTACT

In case of contact with eyes, immediately irrigate the eyes with copious amounts of tepid water for at least 20 minutes. The eyelid should be held apart during the flushing to ensure all accessible tissue of the eyes and the lids are in contact with water. Obtain medical attention.

1.4.4 ACCIDENTAL INGESTION

Ingestion of methanol may be life threatening. Onset of symptoms may be delayed for 8 to 36 hours after ingestion. Do not induce vomiting. Get medical attention immediately. The individual should remain under close medical care and observation for several days.

Treatment of methanol poisoning is well established: administer alkali, ethanol, and hemodialysis. Alkali is administered to combat the accumulation of formate in the blood. Ethanol is administered because ethanol competes with methanol for the enzyme that metabolizes methanol to formate. When ethanol and methanol are both present, the enzyme preferentially metabolizes ethanol. Dialysis is used to enhance the removal of methanol and its toxic products from blood. An antidote (in the form of an injection, fomepizole) is also available to treat methanol poisoning.

1.4.5 MI REFERENCE MATERIALS

This is an excerpt from the Methanol Institute's Safe Handling Manual. For the full manual and a number of other bootleg/adulterated alcohol poisoning reference materials. please visit www.methanol.org/safe-handling/