Workplace Health and Safety
Bulletin
WORK SAFE ALBERTA

Perchloroethylene at the Work Site

Perchloroethylene, also called 1,1,2,2- tetrachloroethylene, PCE and perc (or perk), is a clear, colourless liquid with a sweet odour. The odour is similar to chloroform or ether.

Uses of Perchloroethylene

Perchloroethylene is used mainly as an ingredient in the production of other chemicals, as a metal degreaser in the automotive and other metal working industries and as a solvent in dry cleaning. It appears in a few consumer products, such as paint strippers and spot removers. In addition it is also used in the manufacture of refrigerants, such as HCFC-134a.

Properties of Perchloroethylene

The liquid is heavier than water and the vapour is heavier than air. Perchloroethylene will not burn, but can decompose at high temperatures (greater than 600°F or 316°C) to form gases such as hydrogen chloride, chlorine and phosgene which are very corrosive. Closed containers that are heated can explode due to the build-up of gases and vapours. The chemical is incompatible with metals that are chemically active (for example barium, lithium and beryllium) and oxidizers. Its odour threshold ranges from 2 to about 70 ppm, so odour cannot be relied upon as a warning property. After exposure some people may not smell perchloroethylene as well because they become accustomed to the odour.

Government of Alberta
Employment and Immigration

Health effects

Workers are most often exposed to perchloroethylene by inhaling vapours in the air, or by contact between the liquid and the skin. Perchloroethylene and ethanol are synergistic. This means that the health effects from exposure to the two chemicals together is greater than the effects from the exposure to each chemical alone.

Acute health effects

Short-term exposure to airborne perchloroethylene may cause irritation of the nose and throat and central nervous system depression. Symptoms include drowsiness, dizziness, giddiness, headache, nausea, loss of coordination, confusion and unconsciousness. Acute health effects are summarized in Table 1.

Table 1: Acute Health Effects from Exposure to Perchloroethylene

100 – 200	Headache, drowsiness, dizziness, sleepiness
200 – 600	Incoordination (increases as concentration increases), nose and throat irritation
1000 – 1500	Severe irritation of the nose and throat, faintness and dizziness
>2000	Unconsciousness within 30 minutes, possible damage to the liver and kidneys

Perchloroethylene is a severe skin irritant. Contact with the liquid chemical can cause irritation and blistering of the skin. Prolonged contact can result in second or third degree chemical burns. The eyes can also be damaged or irritated by exposure to the vapour or by direct contact with the liquid from splashes.

Chronic health effects

Long-term health effects include effects to the central nervous system, such as dizziness, forgetfulness, inability to concentrate, mood swings, nausea, fatigue and behavioral changes such as reduced reaction time and incoordination.

Repeated contact with the skin can cause dermatitis (red, itchy, dry and cracked skin).

Cancer

The International Agency for Research on Cancer (IARC) has concluded that perchloroethylene is probably carcinogenic to humans. Perchloroethylene is classified in Group 2A. A number of studies have found that workers exposed to perchloroethylene (particularly in the dry cleaning industry) have an increased risk of cervical, laryngeal, lung and esophageal cancer (cancer of the esophagus).

Health assessment

There is no legislated requirement for workers exposed to perchloroethylene to have a medical assessment. However, where there is doubt whether a worker should be exposed to perchloroethylene, an occupational physician should be consulted.

The American Conference of Governmental Industrial Hygienists (ACGIH) has published Biological Exposure Indices (BEI®) for perchloroethylene in blood, exhaled air and urine. BEIs® adopted by the ACGIH represent levels of a substance likely to be found in samples taken from healthy workers who have been exposed to a chemical to the same extent as workers exposed at the Occupational Exposure Limit (OEL) in Alberta's occupational health and safety (OHS) legislation. The use of biological indices is not a substitute for workplace air monitoring as it measures exposure after the fact.

The BEI for perchloroethylene is:

- Perchloroethylene in exhaled air (measured prior to shift) — 3 ppm
- Perchloroethylene in blood (measured prior to shift) — 0.5 mg/L

Control measures

Preventing exposure to perchloroethylene is the best way to protect health. Options that should be considered include the following (listed in order of preference):

- Use of non-hazardous or less hazardous substitutes
- Use of engineering controls
- Changes in work practices to reduce exposure (administrative controls)
- Use of personal protective equipment

Substitution

Where possible, other solvents or chemicals should be substituted for perchloroethylene. However, these products may themselves have hazards associated with them (e.g. flammability).

The most common use of perchloroethylene is in dry cleaning. In recent years there have been a number of alternative methods developed to reduce the use of perchloroethylene in dry cleaning. These alternatives are summarized in Table 2.

Table 2: Substitution for Perchloroethylene in Commercial Dry Cleaning

Method	Description	Advantages	Disadvantages
Wet cleaning	Water is used for cleaning along with specially formulated detergents and spotting agents and a lower level of mechanical action during washing. There is increased extraction of water before drying, close monitoring of heat and moisture content during drying. About 30 to 70% of garments dry cleaned using PCE can be wet cleaned.	▪ Fewer health and safety hazards ▪ Soil contamination and air emissions eliminated ▪ More pleasant smell than solvent ▪ Some soils are more easily removed ▪ Comparable cost to using PCE	▪ Not a complete replacement for cleaning with PCE ▪ Potential for damage to the garment ▪ Some types of stains more difficult to remove ▪ Large quantities of contaminated wastewater ▪ Labour intensive
Petroleum – Based Solvents	Petroleum based solvents are used instead of PCE in dry cleaning. Equipment generally uses an inert gas and operates under a vacuum.	▪ Solvents less toxic than PCE ▪ Solvent vapour pressures are lower, so exposures are usually lower ▪ Solvent is effective for cleaning most types of garments	▪ Solvents are flammable, so presents a fire hazard ▪ More prone to bacterial growth ▪ Longer drying process required ▪ Less effective at removing oil and grease stains ▪ Equipment usually more expensive
Liquid Carbon Dioxide	Clothes immersed in liquid carbon monoxide in an	▪ Less toxic than PCE ▪ Soil contamination	▪ Less effective at removing some stains

Method	Description	Advantages	Disadvantages
	enclosed system under pressure.	and air emissions eliminated ▪ Shorter cleaning cycle ▪ May be more effective for some types of fabrics ▪ Exposure limits for carbon monoxide much higher	▪ Much more expensive than PCE machines ▪ Newer technology-not proven as with PCE ▪ Potential for asphyxiation if machine is in an enclosed area
Ultrasonic Solvents	Use of high intensity sound waves in fluid to create forces that dissolve and displace contaminants on clothing.	▪ Still under development	▪ Still under development
Alternative Solvents	A number of solvents are being developed for dry cleaning. One type is a mixture of one or more propylene glycol ethers.	▪ Still under development	▪ Still under development

Engineering controls

Engineering controls are processes used to eliminate exposure to a substance.

Engineering controls remove the substance from the air or provide a barrier between the worker and the substance. Examples of engineering controls that can be used to prevent exposure to perchloroethylene include:

- Installation of a ventilation system to remove perchloroethylene vapours
- Enclosures around work processes (fume hoods, glove boxes)
- Use of automatic systems to pump the chemical from storage containers to process containers. This is mandatory in the dry cleaning industry.

- New dry cleaning machine design to reduce the perchloroethylene vapours released (dry-to-dry, closed loop). Environment Canada now requires all machines to be of this standard.
- Isolation of equipment that use perchloroethylene from other work areas
- Use of close loop systems for degreasing

Where ventilation systems are used at the work site, they must be properly designed and not vent back into work areas in accordance with the Alberta OHS Code.

For more information:

- National Institute for Occupational Safety and Health (NIOSH)
  - HC16, *Control of Exposure to Perchloroethylene in Commercial Dry Cleaning* www.cdc.gov/niosh/hc16.html
  - HC17, *Control of Exposure to Perchloroethylene in Commercial Dry Cleaning* (Substitution), www.cdc.gov/niosh/hc17.html
  - HC18, *Control of Exposure to Perchloroethylene in Commercial Dry Cleaning* (Machine Design), www.cdc.gov/niosh/hc18.html
  - HC19, *Control of Exposure to Perchloroethylene in Commercial Dry Cleaning* (Ventilation), www.cdc.gov/niosh/hc19.html
- US Occupational Safety and Health Administration (OSHA)
  Reducing Worker Exposure to Perchloroethylene (PERC) in Dry Cleaning
  www.osha.gov/dsg/guidance/perc.pdf
- US Environmental Protection Agency (EPA)
  Cleaner Technologies Substitutes Assessment: Professional Fabricare Processes
  www.epa.gov/dfe/pubs/garment/ctsa/index.htm

  A summary document is available at:
  www.epa.gov/dfe/pubs/garment/ctsa/sumfctsa.htm

If engineering controls are working properly, they will eliminate or greatly reduce the potential hazard. They only need to be installed once and do not place a physical burden on workers. However, an initial investment is required and the systems must be properly operated and maintained once installed.

Administrative controls

Work practices that can be used in the workplace to reduce exposure to perchloroethylene include:

- Educating workers about the hazards of perchloroethylene. Workers must participate in training and monitoring programs in the workplace.
- Using good hygiene practices. Workers must not eat, drink or smoke in areas where perchloroethylene or products containing perchloroethylene are used and stored. The hands and face should be washed before eating or drinking.
- Properly using and maintaining engineering controls and other equipment used to reduce exposure.
- Storing perchloroethylene properly.
- Ensuring that unprotected workers are not in areas where products containing perchloroethylene are used.
- Cleaning up spills quickly and properly and using appropriate protective equipment and clothing when spills are cleaned up.
- Keeping products containers tightly sealed when they are not in use

Examples of some work practices that can be used to reduce worker exposure during dry cleaning operations include the following:

- Do not load the machine over it's capacity.
- Do not open the machine door while it is running and keep the door closed as much as possible when the machine is not fitted with interlock systems.
- Do not remove garments from the machine before the cycle is completed.
- As much as possible, keep the head and face turned away from the machine door and clothes when removing solvent-laden clothes from the washer.
- Do not transfer perchloroethylene to machines by hand or with open buckets.
- Wait until the machine and solvent are cold before performing maintenance.
- Do not use spotting agents containing perc.
- Clean up spills immediately (a plan should be in place for spill cleanup at the work site).
- Store and dispose of wastes properly

Implementing work practices to reduce exposure can be less expensive than engineering controls, but workers must be properly trained and use the safe work practices. The employer must monitor this in the workplace.

Personal Protective Equipment(PPE)

If it is not practicable or possible to use substitutes, engineering controls or administrative controls to reduce the potential for exposure, or they are not sufficient, the employer must provide workers with appropriate personal protective equipment (PPE).

Respiratory protective equipment is needed to protect workers from inhaling airborne vapours. There are many types of respirators available. It is important to select the correct level of respiratory protection based on the type of work being done and the airborne concentrations of perchloroethylene at the work site.

Properly operating and fitted air-supplying respirators are usually the most effective type of respiratory protection for perchloroethylene vapours. Air purifying respirators with organic vapours cartridges may not provide enough protection from exposure since the concentration of perchloroethylene detectable by most people by smell is higher than the OEL. Because of this, the wearer may not be able to detect when a cartridge is in need of changing and may unknowing become overexposed.

If air-purifying respirators are used for perchloroethylene, the employer must:

- Ensure that the respirator has an end-of-use indicator (the indicator will show when the cartridges must be changed), or
- Use a change-out schedule that has been calculated by a competent person. If a calculated change-out schedule is used, the U.S. Occupational Safety and Health Administration (OSHA) method, or an equivalent method, must be used.
- The employer must also have written procedures that address how the calculations are done, confirm the method used for the calculations and specify training to ensure that workers understand and use the system for cartridge change out. The OSHA method may be accessed online at www.osha.gov/SLTC/etools/respiratory/change_schedule.html

For more information

http://employment.alberta.ca/documents/WHS/WHS-PUB_ppe004.pdf
Guideline for the Development of a Code of Practice for Respiratory Protective Equipment - PPE004

http://employment.alberta.ca/documents/WHS/WHS-PUB_ppe001.pdf
Respiratory Protective Equipment: An Employer's Guide – PP001

Employers should also refer to the CSA Standard Z94.4-02, *Selection, Use and Care of Respirators.*

Since perchloroethylene is absorbed through the skin, solvent resistant gloves and other protective clothing are needed for workers who handle the chemical and items contaminated by perchloroethylene. Workers who may be exposed to perchloroethylene should wear protective clothing that covers and protects the eyes, arms and legs. Workers should also wear airtight goggles or full-face respirator masks to protect the eyes from irritation or splashes. Where skin contact occurs, the area should be thoroughly washed immediately. Information about protective clothing materials recommended for perchloroethylene is available from NIOSH database "Recommendations for Chemical Protective Clothing". The database is available online at: www.cdc.gov/niosh/ncpc/ncpc2.html

Although the use of PPE may initially seem less costly, workers must be trained to use, care for and properly maintain the protective equipment. Employers must monitor use and ensure that the protective equipment is properly maintained. In some cases, PPE can create a hazard to workers (heat stress, limited vision, allergic reactions to the equipment material). These issues must be evaluated when personal protective equipment is selected.

Workplace air monitoring

When perchloroethylene or a product containing perchloroethylene is used in the workplace, air monitoring must be done to ensure that the Occupational Exposure Limit (OEL) is not exceeded. Air samples must be collected and analyzed using a method specified in Section 20 of the Alberta OHS Code or a method approved by a Director of Occupational Hygiene.

For leak detection of equipment, small hand-held refrigerant leak detectors or colorimetric detector tubes can be used. There are more sophisticated direct-reading instruments available that can be used (infrared analyzers, photoionization detectors) that will provide more accurate readings of perchloroethylene concentrations. However, these instruments tend to be more expensive and require more training to operate.

Regulatory requirements

The Alberta OHS legislation has general and specific requirements related to perchloroethylene. An OEL for perchloroethylene is provided. This limit applies to workers directly involved with tasks using perchloroethylene or products containing perchloroethylene, and to other workers in a workplace who may be exposed to perchloroethylene indirectly from these operations. Is it important to note that OELs represent standards for the protection of the most healthy workers. Steps must be taken to keep airborne perchloroethylene exposure as low as reasonably practicable/achievable.

The employer must also:

- Train workers on the health hazards from exposure to perchloroethylene and the safe work procedures developed by the employer
- Ensure that the need for ventilation and other engineering controls are properly assessed and systems that are installed are properly designed and maintained. Workers also must be trained on the proper operation and maintenance of these systems.
- Provide appropriate PPE (including respirators) where the concentration of perchloroethylene cannot be controlled below the safe limit. Workers must use the required PPE and must be trained on their proper use and care.

Contact us:

Province-Wide Contact Centre

Edmonton & surrounding area:
780-415-8690

Throughout Alberta:
1-866-415-8690

Deaf or hearing impaired
- In Edmonton: **780-427-9999**

or
- **1-800-232-7215** throughout Alberta

Web Site

www.worksafely.org

Getting copies of OHS Act, Regulation & Code:

Queen's Printer

www.qp.gov.ab.ca

Edmonton 780-427-4952

Workplace Health and Safety

http://industry.alberta.ca/whs-ohs

Call any Government of Alberta office toll-free
Dial 310-0000, then the area code and telephone number you want to reach