



Alternative Solvents: Health and Environmental Impacts

In January, 2007, the California Air Resources Board (ARB) amended its regulations addressing perchloroethylene (Perc) emissions from dry cleaning operations. The following deadlines apply:

- January 1, 2008: No new sale or lease of Perc machines;
- July 1, 2010: All Perc machines at co-residential facilities must be removed;
- July 1, 2010: Perc machines 15 years and older may no longer be used;
- January 1, 2023: Perc machines may no longer be used.

The ARB determined that the benefits from dry cleaning alternatives outweigh the negative health and environmental impacts from the use of Perc. However some questions have been raised about potential health impacts of alternatives to Perc. This notice describes the available alternative solvents and provides current information on their health and environmental impacts.

The alternative solvents listed are in use in California. This information is not meant to be exhaustive as other solvents may also be available.

Approved Non-toxic and Non-smog-forming Dry Cleaning Technologies

These systems qualify for grant money under California's Non-Toxic Dry Cleaning Incentive Program, established by Assembly Bill (AB) 998.

Water-Based Cleaning

Water-based cleaning systems use water and detergents to clean garments. Currently, there are four types available and qualify for incentives: 1) professional wet cleaning systems; 2) cold water cleaning systems; 3) Green Jet™ dry-wet cleaning™ systems and 4) Green Dry-2-Dry systems.

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Most detergents used in wet cleaning are a complex mixture of water and chemicals. Because there are a wide variety of formulations, it can be difficult to determine the toxicity of specific products. In general, detergents are approved for disposal into sewer systems by local sanitation districts. The United States Environmental Protection Agency examined the human health and environmental hazards of the primary components of detergents and found no expected health risks to the general public.

Carbon Dioxide (CO₂)

The CO₂ process, developed by commercial and retail dry cleaners, is a high pressure system using liquid CO₂ as the cleaning solvent.

Financial Assistance

Financial assistance is available for water-based and CO₂ cleaning systems through the AB 998 Non-Toxic Dry Cleaning Incentive Program. This program provides \$10,000 grants to dry cleaners that choose to replace their Perc dry cleaning system with a non-toxic and non-smog forming system. Currently, only water-based and CO₂ cleaning systems qualify as approved technologies. Demonstration grants are also available for those cleaners selected to become a demonstration site facility. More information can be found at www.arb.ca.gov/toxics/dryclean/ab998.htm.

In addition to ARB's Non-Toxic Dry Cleaning Incentive Program, some local air districts offer incentives for water-base and CO₂ cleaning systems. A list of the local air districts' contact information can be found on the following website: www.arb.ca.gov/capcoa/roster.htm.

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CO₂ is a non-flammable, non-toxic, naturally-occurring gas that becomes a liquid solvent when subjected to pressure. There is no expected health risk to the general public from these processes. Questions have been raised because CO₂ is a greenhouse gas which contributes to global warming. Although the amount of emissions from dry cleaning processes have not been studied, the CO₂ used in the dry cleaning processes is a by-product from industrial operations and therefore does not contribute to the greenhouse gas inventory.

Other Available Dry Cleaning Technologies

The following solvents are currently being used in California as alternatives to Perc.

Hydrocarbon Solvents

Currently, the types of hydrocarbon solvent technologies available are: 1) DF-2000™ Fluid; 2) PureDry®; 3) EcoSolv®; and 4) Shell Sol 140 HT. The machines predominately used for hydrocarbon solvents are closed-loop machines equipped with primary controls. Detailed information on each of the hydrocarbons is available in the ARB staff report available at www.arb.ca.gov/regact/2007/perc07/perc07.htm.

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There is limited health information on these hydrocarbon mixtures. None of the hydrocarbon solvents have undergone formal evaluation by California for identification as toxic air contaminants (TAC). A detrimental and secondary health effect of the alternative solvents is that all hydrocarbon solvents are considered volatile organic compounds (VOC). VOCs contribute to the formation of ozone which is linked to many ill-health effects including respiratory irritation, asthma, and premature death. VOC emitting systems require air permits.

GreenEarth® (Volatile Methyl Siloxane)

Decamethylcyclopentasiloxane (D5) or volatile methyl siloxane is an odorless, colorless liquid that has many consumer and industrial applications. D5 is the ingredient present in the GreenEarth® dry cleaning solvent used in multi-solvent machines. The ARB does not consider D5 to be a VOC.

- **Health and Environmental Impacts**

California's Office of Environmental Health Hazard Assessment (OEHHA) conducted an evaluation of the available D5 information and concluded that exposures of D5 at the highest achievable vapor concentrations cause uterine tumors in rats. OEHHA is also concerned about the potential non-carcinogenic effects associated with D5 and its apparent persistence in the environment and animal and human tissues. However, available exposure information indicates that the use of D5 as an alternative dry cleaning solvent will not pose a risk to the public living near businesses using D5. D5 has not undergone formal evaluation for identification as a TAC.

Rynex™ (Rynex 3 or Propylene Glycol Ether)

Rynex™ (Rynex 3) is an organic and biodegradable solvent with low volatility and a high flash point. It is considered a VOC and requires an air permit. Rynex 3 can be used in most hydrocarbon machines with some temperature and timing adjustments.

- **Health and Environmental Impacts**

Rynex 3 consists of a mixture of glycol ethers. This solvent brand has changed formulation since its inception. Based on a recent study by the National Toxicology Program (NTP) on the glycol ether ingredient of a previous formulation for Rynex™, propylene glycol t-butyl ether (PGtBE), OEHHA has expressed concerns over its toxicity and carcinogenic potential. Of particular concern, was the presence of tumors in mice. More detailed information on the toxicological studies for the previous formulation of Rynex™ can be found in the Technical Assessment Report. Rynex 3 represents the current formulation for Rynex™, which does not contain PGtBE but instead contains dipropylene glycol tert-butyl ether (DPTB). Currently, there is limited toxicity data available for DPTB. It has not undergone formal evaluation for identification as a TAC.

Limited Use Dry Cleaning Technologies

DrySolv™ (1-Bromopropane (n-propyl bromide))

1-Bromopropane (n-propyl bromide or n-PB) is an emerging solvent. It is considered a VOC and requires an air permit. Although this solvent is being used in modified perchloroethylene-dry-cleaning machines with secondary control, industry representatives are concerned that n-propyl bromide's inherent properties may lead to more leaks and emissions in such machines.

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According to the California Department of Health Services, this solvent is a neurotoxicant and reproductive toxicant and is listed under Proposition 65 as a reproductive toxicant. It causes sterility in both male and female test animals, and harms developing fetuses. It can damage nerves, causing weakness, pain, numbness, and paralysis. 1-Bromopropane has a strong odor and is a more volatile compound than Perc, thus increasing its potential for nuisance problems and exposure to near-by residents. In their 13th Report on Carcinogens (2014), the U.S. Department of Health and Human Services NTP listed 1-bromopropane as "reasonably anticipated to be a human carcinogen." This finding is supported by the clear evidence of carcinogenicity in both female rats and mice in their study. This compound has not undergone formal evaluation for identification as a TAC.

Solvair™ (dipropylene glycol normal butyl ether/ CO₂)

The Solvair equipment uses a closed loop process in which dipropylene glycol n-butyl ether (DPNB) is used as the base cleaning solvents and liquid CO₂ is used to rinse out the solvent and dry the garments. Dipropylene glycol normal butyl ether is considered a VOC and requires an air permit.

- **Health and Environmental Impacts**

DPNB is a type of propylene glycol ether. Currently, there is limited toxicity information available for DPNB. It has not undergone formal evaluation for identification as a TAC. There is no expected health risk from the exposure to the CO₂ used in the Solvair technology.

SolvonK4 (formaldehyde dibutyl acetal)

The SystemK4 is a recently available commercial dry cleaning technology that uses SolvonK4 as the solvent. Although there are machines that are designed for use with System K4, SystemK4 can also operate in equipment designed for hydrocarbon or GreenEarth® solvents after some retrofit. SolvonK4 (formaldehyde dibutyl acetal) is considered a VOC and requires an air permit.

- **Health and Environmental Impacts**

Currently, there is limited toxicity information available for SolvonK4. It has not undergone formal evaluation for identification as a TAC.

Fire Hazard Considerations

The alternative dry cleaning technologies listed in this notice, with the exception of water-based and CO₂ cleaning technologies use solvents that may be regulated by local Certified Unified Program Agencies (CUPA) because of their flammability and/or combustibility. CUPA contact information may be found at www.calepa.ca.gov/CUPA/Directory/default.aspx.

In addition, the Office of the State Fire Marshal (SFM) has adopted the 2013 California Fire Code (CFC). The 2013 CFC, chapter 21 retained the option for existing dry cleaners to satisfy National Fire Protection Association 32: Standard for Dry Cleaning Plants (NFPA 32) as a viable alternative. NFPA 32 allow dry cleaning operations to convert from Perc to Type II or Type III dry cleaning systems without full building automatic sprinkler protection, provided certain provisions of NFPA 32 are met. These provisions include but are not limited to: 1) solvents are limited in quantity; 2) provisions for 2 and/or 3 hour fire barrier separation; and 3) equipment protection/limitation provisions. For more detailed information regarding NFPA 32, please visit the related link on the SFM's website at: <http://osfm.fire.ca.gov/codedevelopment/codedevelopment.php> or CFC, Chapter 21 at www.ecodes.biz/ecodes_support/free_resources/2013California/13Fire/PDFs/Chapter%2021%20-%20Dry%20Cleaning.pdf

For More Information

More information on the alternative technologies may also be obtained from the following website: www.arb.ca.gov/toxics/dryclean/dryclean.htm. This website contains regulatory information and formal rulemaking documents. For more information on the status and requirements of the amended Dry Cleaning Air Toxic Control Measure, please contact one of the following ARB staff.

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Alternately, you may email questions to dryclean@arb.ca.gov.