# HEALTH ALERT

## Trichloroethylene (TCE) and Reproductive Risk

*February 2015*

## Summary

TCE presents a risk to pregnant women and women of reproductive age at air concentrations well below OSHA's Permissible Exposure Level (PEL). Recent evidence suggests that TCE exposure during pregnancy can increase a baby's risk of cardiac defects and immune disorders. Employers should minimize worker exposure to TCE and implement best management practices to reduce TCE in the workplace. This health alert provides employers with resources to decrease TCE exposure and thus prevent reproductive risks in the workplace.

## What is TCE?

TCE is a chlorinated solvent that is used to degrease metal parts and machinery. It is also used as an intermediate in hydrofluorocarbon manufacture, and in the formulation of adhesives and printing inks (ATSDR, 2013). The most recent Toxics Release Inventory (TRI) data show that a number of Connecticut facilities handle and release TCE into the environment (TRI 2013). This suggests that worker exposure to TCE can occur in various establishments across Connecticut.

## How Can Workers Be Exposed to TCE?

TCE is a volatile chemical which means that liquid TCE forms a vapor which can be inhaled. TCE is also absorbed across the skin from direct contact. Even if not working with TCE directly, a worker can still inhale this chemical from the work that others are doing in the same room. Job activities which involve direct handling of TCE will cause the greatest exposure.

A compilation of TCE data across industrial users found a range of workplace air concentrations, with most in the parts per million (ppm) range (Bakke et al. 2007). This is relatively high when considering the levels that are a risk during pregnancy. While the workplace data are primarily from the 1970s and 1980s, the most recent data from the 1990s still show ppm levels of TCE to be common in workplace air (Bakke et al. 2007).

## What are TCE's Effects on Fetal Development?

TCE has produced cardiac defects in rats when exposure was during the course of gestation (USEPA 2011). This birth defect was found in rat studies not only with TCE but with its metabolites suggesting that TCE may need to be metabolized to cause the birth defect. TCE was also associated with cardiac defects in a human study in which a neighborhood was contaminated with TCE in soil (Forand et al. 2012). This led to indoor air exposures and higher rates of cardiac defects in the TCE-affected area. This combination of animal and human evidence raises a significant concern for TCE developmental risks in spite of several other animal studies not showing this effect. Another TCE effect on the developing fetus is impairment of the immune system (USEPA 2011). The implication of this finding is increased infection and allergy in children who were exposed to TCE before birth. Both the USEPA and the ATSDR air targets for protection of public health are based upon these early life developmental effects of TCE (USEPA 2011; ATSDR 2013).

## How can TCE Exposure be Avoided in the workplace?

Workplaces storing, handling or disposing of TCE should follow best management practices to minimize worker exposure to this volatile chemical. This is especially important if pregnant women or women of childbearing age are in the workplace. Some of these recommended practices include:

**Storage -** containers of TCE should be well sealed and stored in otherwise unused parts of the building; this storage should be away from air intake for the heating, ventilation and air conditioning (HVAC) system.

**Cleanup -** protocols should be developed and materials on hand to clean up TCE spills in case they occur.


**Ventilation -** well maintained HVAC system is critical in areas where TCE is handled along with specially designed local exhaust ventilation for high use activities (e.g., pouring, mixing, applying TCE).

**Air monitoring -** this is needed to document that TCE concentrations are maintained below levels of worker health concern.

**Protective clothing -** workers directly handling TCE should wear protective gloves and clothing.

**Alternative job assignments -** as a precaution, workplaces should consider assigning pregnant women to areas and job categories that do not involve direct handling of TCE.

**Alternative solvents -** companies are encouraged to seek alternative solvents that do not have the reproductive and carcinogenic risks of TCE. The Toxics Use Reduction Institute (TURI) housed at the University of Massachusetts Lowell is an excellent resource for finding TCE replacements. They have helped companies in Massachusetts reduce TCE use by 90% or more. Their website cleanersolutions.org can help you find a suitable replacement based upon your specific combination of metal substrate, soiling material, and degreasing equipment. To discuss your specific needs they can be contacted at 973-934-3133.

**Respiratory protection -** if pregnant women are in jobs that involve direct handling of TCE, respirators containing an organic vapor cartridge should be worn unless workplace monitoring documents that air concentrations are below USEPA reproductive guidance levels (see below). Respirators should only be used in conjunction with an OSHA-compliant respiratory protection program, which includes appropriate fit testing, training, and medical clearance for use of a respirator (*see OSHA Respiratory Protection Standard: 29 CFR 1910.134*). Medical clearance for respirator use by pregnant women is particularly important, as the increased respiratory burden of filtering facepieces may preclude their use during pregnancy (Roberge 2009).

**Education -** workers and especially women of child-bearing age should understand the health risks posed by TCE and be trained in proper solvent handling techniques and respirator use.

## Workplace Standards and Guidelines for TCE in Air:

To avoid risk to fetal development USEPA Region IX has set a target workplace air concentration of 8 micrograms per cubic meter (ug/m3, equivalent to 1.5 ppb) for TCE coming from vapor intrusion from contaminated soil or groundwater. USEPA has set an urgent response action level of 24 ug/m3 (4.5 ppb) for more immediate action including informing workers of the health risk (USEPA 2014). These targets are supported by recent toxicology reviews by USEPA (USEPA, 2011; Chiu et al 2013) and are similar to TCE workplace targets set in Massachusetts for vapor intrusion (MADEP 2014). As shown in the table, the USEPA Region IX and Massachusetts targets are well below the OSHA PEL and serve as useful guides to preventing TCE risk to fetal development in the workplace.

| Agency | Standard/Guideline | Concentration | Key Health Effect |
|---|---|---|---|
| OSHA | PEL | 100 ppm | Brain, liver in adults |
| ACGIH | TLV | 10 ppm | Brain, kidney in adults |
| USEPA Region IX | Workplace Guideline | 0.0015 ppm | Fetal toxicity |
| USEPA Region IX / MA DEP | Immediate Action Guideline | 0.0045 ppm | Fetal toxicity |

The OSHA PEL is dated and was based upon TCE's effects in adults (OSHA 1989). The American Council of Governmental Industrial Hygienists (ACGIH) has established a more recent workplace guidance value, called a Threshold Limit Value (TLV) of 10 ppm. However, neither the OSHA PEL nor the ACGIH TLV focus on TCE's effects on pregnant workers. This has been addressed by very recent guidance by USEPA.

## References:


Agency for Toxic Substances and Disease Registry (ATSDR) Toxicological Profile for Trichloro-ethylene, Addendum(2013). https://www.atsdr.cdc.gov/toxprofiles/tp19.pdf

Bakke B, Stewart PA and Waters MA (2007) Uses of and exposure to trichloroethylene in U.S industry: a systematic literature review. Journal of Occupational and Environmental Hygiene, 4: 375-390 (2007).

Chiu WA, Jinot A, Scott CS et al. (2013) Human health effects of trichloroethylene: key findings and scientific issues. Environ Health Perspectives 121: 303-311.

Forand SP, Lewis-Michl EL and Gomez MI. (2012) Adverse birth outcomes and maternal exposure to trichloroethylene and tetrachloroethylene through soil vapor intrusion in New York State. Environ Health Perspective 120: 616-621.

MADEP (Massachusetts Dept of Environmental Protection) (2014) Important Information on TCE in Workplace Indoor Air at http://www.mass.gov/eea/docs/dep/cleanup/laws/tcewkin.pdf.

Marshall, Jason P., Wilcox, Heidi. (2015). In Search of the Silver Bullet: Assessment of Alternatives for Trichloroethylene in Cleaning Operations. Toxics Use Reduction Institute, University of Massachu-setts Lowell, Lowell, MA, USA, and others.

OSHA (Occupational Safety and Health Administration) PEL Project Documentation (1989), Trichloro-ethylene at http://www.cdc.gov/niosh/pel88/79-01.html.

Roberge RJ (2009) Physiological burden associated with the use of filtering facepiece respirators (N95 masks) during pregnancy. J Womens Health 18: 819-826.

Toxics Release Inventory (TRI) database 2013 search for Connecticut facilities that release trichloroethylene at https://www.epa.gov/toxics-release-inventory-tri-program.

USEPA (2011) IRIS Profile for Trichloroethylene at http://www.epa.gov/iris/subst/0199.htm.

USEPA (2014) EPA Region 9 Response Action Levels and Recommendations to Address Near-Term Inhalation Exposures to TCE in Air from Subsurface Vapor Intrusion https://archive.epa.gov/region9/superfund/web/pdf/r9-tce-interim-action-levels-response-recs-memo-2014.pdf.


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**For More Information:** Contact the CT Dept. of Public Health Occupational and Environmental Health Assessment Program at 860-509-7740 for questions about mitigation of TCE health risks or for a free Workplace Hazard Assessment.