# Frequently Asked Questions (FAQ)

## 1. What is trichloroethylene (TCE)?

Trichloroethylene (TCE) is a colorless liquid with a somewhat sweet odor and a sweet, burning taste. It is nonflammable at room temperature. TCE is used mainly as a solvent to remove grease from metal parts, and as an ingredient of adhesives, paint removers, typewriter correction fluids, spot removers, and refrigerants. TCE does not occur naturally in the environment; however, it has been found in underground water sources and many surface waters as a result of the manufacture, use, spills, leaks, and disposal of the chemical. Nationally, TCE use has declined in recent years, as it has been replaced by safer substitutes. TCE is no longer in general use at ERDC-CRREL.

## 2. What happens to TCE when it enters the environment?

TCE has the potential to migrate into soil and groundwater where it can remain since it is moderately water soluble. TCE is highly volatile and therefore it evaporates quickly from shallow water, sediment, and soil at increasing temperatures. TCE may resist movement when adsorbed (stuck) to materials with high organic content such as soil or sediment. TCE in deeper soil can move as a vapor via tiny spaces in the soil. Soil gas with TCE can follow pathways to the atmosphere or into buildings via cracks, penetrations, or open doors and windows. TCE can also enter into a building as a result of evaporation from household use of contaminated water (e.g., showering or washing). TCE tends to degrade into other chemicals (that also degrade) when exposed to sunlight. TCE does not tend to accumulate in plants and animals, including humans.

## 3. Is TCE present in groundwater at CRREL?

Yes, TCE has been detected in groundwater at CRREL due to past spills. Since 1993, CRREL has been removing TCE from groundwater pumped from four extraction wells used for cooling water at the facility. Annual sampling of CRREL's monitoring well network to date indicates that TCE in groundwater is not migrating off of CRREL property. The CRREL facility and neighboring properties are all served by town water.

## 4. Has the US Army Corps of Engineers (USACE) checked for TCE in the indoor air in CRREL facilities?

Yes. TCE vapors have been detected in several locations in CRREL buildings at levels that require further evaluation and future actions. TCE vapors came from past spills at the facility. Air samples have been collected inside buildings and in the soil gas below building slabs at CRREL. Nine rounds of sampling have

been conducted from 2010 to 2014 at various locations. TCE, its breakdown products, and other volatile chemicals used at CRREL are the focus of the investigation.

Sample results show that TCE is present both in the air inside of buildings and in the soil gas outside of the buildings at CRREL. Monitoring of indoor air and sub-slab soil gas is ongoing, as are efforts to reduce exposure. Testing and evaluation is conducted over a period of at least one year to better understand the seasonal variations of the vapor concentrations and movement.

## 5. What were the results of indoor air monitoring at CRREL?

TCE vapors in indoor air at CRREL vary by location, season, time of day, heating/cooling system operations, and whether doors or windows are open or closed. Exposure Point Concentrations (EPC) of TCE at various places at the facility range from estimated concentrations that are so low they cannot reliably be quantified (between 0.09 $\mu g/m^3$ and 0.67 $\mu g/m^3$) up to a single high measurement of 320 micrograms per cubic meter at one location.

## 6. What potential health effects are associated with exposure to TCE?

Observed health effects are generally dependent on the intensity of exposure. Breathing high concentrations of TCE may in the short term cause headaches, lung irritation, dizziness, poor coordination, and difficulty concentrating. Much lower levels of exposure over the long term can produce central nervous system effects, kidney and liver damage, and affect the immune system.

Human health risk assessment focuses on two types of effects at low levels of exposure: *non-cancer* and *cancer*. Non-cancer effects for TCE include diminished immunity, changes to the liver, and cardiac malformations in developing fetuses. Cancer effects of TCE include non-Hodgkin lymphoma (a type of blood cancer involving white blood cells), liver cancer, and kidney cancer. Because children are thought to be especially sensitive to certain cancer-like (mutagenic) health effects, the calculations for risk action levels are modified to account for increased sensitivity of exposed children aged 0 to less than 2 years, 2 to less than 6 years, and 6 to less than 16 years.

USEPA states that TCE is characterized as “carcinogenic to humans” by all routes of exposure. This conclusion is based a causal association between TCE exposure and kidney cancer in humans.

The low levels of exposure we are evaluating are much lower than those tolerated in industrial settings. At these low levels of exposure, very little information is available about health effects in humans. Experiments on animals are used to better understand possible health effects in humans. Test animals are typically fed large amounts of TCE to rapidly induce an effect. The same effects seen in animals are thought to occur in people exposed to TCE, so the USEPA has developed toxicity values from the animal studies to estimate human health risk.

## 7. What is an acceptable level of TCE in indoor air at CRREL?

For CRREL facility employees, an Exposure Point Concentration (EPC) of 8.8 micrograms per cubic meter is considered to be a safe level for the potential non-cancer concerns that were identified in a site-specific interim human health risk assessment. At the observed levels of TCE vapor, non-cancer rather than cancer effects were found to warrant interim response actions. The interim action level is a site specific value developed using the latest U.S. EPA toxicity values (September 28, 2011) and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, commonly known as Superfund) risk assessment guidance. This value is protective of lifetime exposures to workers and people who may be more sensitive than usual to those exposures.

## 8. What were the results of the interim risk evaluation of vapors at CRREL?

All of the estimated cancer risks are lower than the action threshold defined in the National Contingency Plan of 1 in 10,000, which means the estimated cancer risks may be considered acceptable.

Corrective response is not required at most of the buildings where the non-cancer hazard index (a reference point) is equal to or less than 1, which according to the National Contingency Plan is generally acceptable. However, non-cancer hazards do require interim responses to mitigate exposure at the following locations: Laboratory Addition basement, Laboratory Addition sub-basement, and portions of the Main Laboratory.

## 9. What is being done to address potential employee and public exposure to TCE vapor?

The following actions have been implemented at the CRREL facility to reduce the potential for exposure:

- Portable air purification systems are deployed throughout the Main Lab and Lab Addition basements. These systems have been in place for more than a year and have proven to be effective. The air purifier cartridges were replaced in October 2013.
- A sub-slab depressurization system was installed in the Child Development Center (CDC) and testing shows that it is effective.
- Ongoing, real time monitoring of indoor air quality in Main Lab and the Technical Information Analysis Center (TIAC) with the portable Hapsite. Twenty-four day sampling of the Main Lab was completed in August to check how concentrations vary over a critical timeframe.
- Multipurpose Room (in Main Laboratory) pilot subslab vapor treatment system was completed in August and regular operation has commenced. The pilot study report is undergoing review.
- A pilot test subslab depressurization system was installed in the Main Laboratory Basement and Laboratory Addition Basement in November 2013. Testing indicates that the system is successfully reducing infiltration of TCE vapors. This system will continue to operate as additional suction points are installed and the blower system is modified.
- A subslab depressurization system was installed as a precaution during construction at the Technical Information Analysis Center (TIAC) basement, in case it is needed in the future.

- Another round of indoor air and sub-slab sampling (Event 9) of Main Laboratory, Child Development Center, Logistics Management Office, Frost Effects Research Facility, TIAC, and the Greenhouse was completed in February 2014. Laboratory analysis, data validation and report preparation are underway.

## 10. Why has USACE been sampling indoor air beyond the boundary of CRREL?

TCE vapors are present deep in the soil at the CRREL property and some neighboring properties. Different types of soil and underground structures can affect the movement of the vapors. Samples of indoor air are needed to confirm that TCE is not migrating upwards into buildings beyond the CRREL boundary.

To date, the sampling has shown that TCE vapors, where present beyond the facility boundary, are at levels below the risk-based screening levels intended to protect people. Because seasons, weather and other factors affect vapor migration into buildings over time, USACE will continue to monitor indoor air and subslab soil gas quarterly at the Middle School and at least twice per year at other locations. The following actions have been implemented on neighboring properties:

- Two rounds of indoor air and sub-slab sampling were completed at Brendel & Fisher, and Hanover Chiropractic & Yoga in April and November 2013. The draft data report was submitted to USACE in January 2014, with subsequent delivery to stakeholders.
- Two rounds of indoor air and sub-slab sampling were completed at Dartmouth Housing south of the CRREL property in April and October 2013. The report has been delivered to the stakeholder.
- Two rounds of indoor air and sub-slab sampling were completed at Dartmouth Printing in September 2013 and January 2014. Soil vapor sample points were installed and soil vapor sampled in early November 2013. The data report was submitted for USACE review in January 2014, and subsequently delivered to the stakeholder.
- Three rounds of indoor air and sub-slab sampling at Richmond Middle School were completed in April and August 2013 and January 2014. The draft reports for the first two rounds were submitted to the school district and to USACE for review. The Round 3 draft data report has been delivered to the stakeholder.
- Soil vapor implants were installed north of CRREL on the Dartmouth Rivercrest property in early December 2013. Sampling planned for December was postponed due to an equipment problem, successfully occurring in early January 2014. The data report is being prepared.

## 11. What additional studies are planned for the environmental investigation?

The following activities are planned for the ongoing remedial investigation of the CRREL property:

- Bedrock and overburden drilling program started in late February 2014.
- Groundwater sampling program for existing and new wells is scheduled for May and June 2014.
- Aquifer pumping test to optimize groundwater extraction is scheduled for July 2014.
- Supplemental ambient air sampling and analysis using a portable testing unit (Hapsite) will be ongoing, with additional monitoring at the Main Lab and TIAC.

- Soil vapor extraction pilot test starting in May 2014.

## 12. Are there any plans to test other places beyond the facility boundary? I am concerned about TCE vapors settling in near my home.

The USACE has sampled air in buildings, sub-slab, shallow and deep soil gas and ambient air on properties adjacent to CRREL to determine the potential for vapor intrusion into buildings. Repeated sampling at these properties will help determine whether soil vapors may extend even further beyond the property boundary. However, at this time there is no evidence that vapors are intruding into any buildings beyond the CRREL property, so more extensive sampling may not be needed.

Dilute TCE vapors do not tend to "settle" out of the air. Rather, they become dispersed and tend to flow with the air. Low levels of TCE in the atmosphere are not unusual, as they are commonly found to come from a variety of sources in the community background. In some places the background level can sometimes be higher than the screening levels for indoor air from vapor intrusion (USEPA, *Toxicological Review of Trichloroethylene*, Chapter 2, section 2.3.1).

## 13. How is indoor air testing done?

Indoor air testing is done by gathering samples of air that people breathe inside while at work, school, daycare, or at home. Samples of soil gas from beneath the concrete basement or floor slab are collected at the same time through holes drilled through the concrete slab to check if vapors are there. The number and location of these subslab sample locations depends on the size, construction, and layout of the building.

Samples are collected into "summa canisters" that are typically about the size of a basketball. Before sampling, the canister is certified as clean, and air is pumped out to create a vacuum. The evacuated canisters are then placed in the building, opened, and the indoor air slowly gets drawn in through a flow regulator. When the time is up, the valve is closed and the container is sent to the laboratory to measure the captured TCE and other volatile organic compounds.

We also analyze "grab samples" of air using portable equipment that can give a reading of TCE at the moment. Grab samples are very useful for immediately tracking vapors at different times and places. We have found the grab samples to provide very useful and rapid results. If concentrations vary through the day, a single grab sample may have a different result than a longer term sample collected over a full day, so we carefully take that into consideration on a case-by-case basis.

## 14. If TCE is found in the air inside, how long has it been there?

Sampling will tell us whether TCE and other vapors are present, but not how long they have been there or how long they will remain. If TCE has been in the soil and groundwater at CRREL for many years, it's possible that soil vapors also may have been there for a long time, especially at greater depths. Shallower soils in the area are denser and tighter and thus less permeable than the deeper soil, so

vapors don't tend to migrate upwards. Because TCE is no longer being used and the soil gas is aged, the soil gas plume is unlikely to further expand.

## 15. How do the TCE levels in air in and around buildings outside of CRREL compare to the "safe level"?

Beyond the CRREL facility boundary, indoor and outdoor air samples have all been below action levels established for protection of health. This indicates safe conditions with respect to TCE exposure at those places. Exposures approaching health protective levels have been found within some of the buildings on the CRREL property, so we have responded by relocating people and installing systems to remove the TCE vapor.

The safe level will depend on how much exposure is occurring and for how long. Therefore, it will differ in the workplace, school, or home. At low levels of exposure, it usually takes many years of exposure for health effects to be expected. However, during pregnancy the allowed timeframe for exposure to TCE is much shorter than usual. To assure safe exposure levels at all times, we are gathering numerous and frequent samples.

We are also checking background levels of TCE in the atmosphere that may come from a variety of sources in the community. In rural areas and cities, the background level is sometimes higher than some health based concentrations for indoor air from vapor intrusion. (US EPA, *Toxicological Review of Trichloroethylene*, Chapter 2, Section 2.3.1).

## 16. I have spent several years in a building that will be sampled. Will I get sick?

Based on our current understanding of health effects resulting from exposure to TCE, whether a person is affected depends on the period and intensity of exposure. For example, health risks can be estimated based on an exposure at some concentration for 8 hours per day for 25 years for a worker, 7 hours per day for 5 years for a child in middle school aged 10 to less than 15 years, and 24 hours per day for 30 years for a household resident. These are projections based on air sample results and calculations, not medical tests or surveys of illnesses.

At low levels of exposure, health effects are more difficult to observe than they are at short-term, high intensity exposures. At very low levels of exposure, studies of human populations (epidemiology) often find no clear measurable or statistical effect. In the case of TCE, non-cancer effects in humans are inferred from tests done with animals, in which high level exposures to the test subjects are scaled down to lower environmental levels. Cancer effects, however, have been directly observed in human populations.

Because exposure to high concentrations of TCE in the work place may cause health effects in less time, people working with TCE are trained to limit exposure to defined permissible limits during the work day, such as by using personal protective equipment or limiting hours of exposure. Short term occupational limits for workers are set much higher than the limits for people exposed to low levels of TCE over time.

## 17. Is my child at risk from TCE exposure while participating in athletic events on the middle school athletic fields?

No. We have asked the same question and conducted sampling of the outdoor or ambient air near the athletic fields. The results show non-detectable levels or occasional trace amounts of TCE. The trace amounts are below action levels, and are so low that the quantities are estimated. Additionally, there is no historic evidence of TCE use on the school property and no known spills on the athletic fields that could have contaminated the soil to provide a source of TCE on the property.

## 18. How would I know if I have experienced any health effects?

We estimate health effects by measuring vapors in the air. Because we measure air samples rather than exposed people, we do not know if a health effect is tied to any particular TCE exposure. We can only say whether an effect may reasonably be expected following exposure. If the risk is greater than acceptable limits defined by law, we can take measures to mitigate exposure and reduce risk.

There are many environmental influences beyond TCE that might have similar confounding health effects. For example, the human immune system is a complex system that may be affected by TCE, viruses, bacteria, and everyday stress.

## 19. What can I do as an individual to protect myself if TCE is found where I am?

You should minimize your exposure if necessary. If TCE vapor levels are identified, you should determine whether your work space is in an area where TCE vapors are above acceptable levels. You should aim to minimize your time exposed and the level of exposure to reduce risk. Those steps may include better ventilation, air purifiers, and preventing TCE vapor from entering the building in the first place.

## 20. Can I be tested for any problems due to TCE exposure?

Yes. There are tests that can measure TCE concentration in your breath, blood, or urine, but the measurements are less reliable at the lower levels of exposure. The medical tests use equipment that may not be available at most doctors' offices.

TCE does not stay in the body for more than several days, so it must be measured soon after exposure. For a short time after exposure, a breath test can help detect exposure to low levels of TCE. Blood tests for trichloroethylene blood or plasma levels may provide a qualitative indication of an exposure. Exposure to TCE may also be indicated if trichloroacetic acid or trichloroethanol are detected in blood or urine; however, those indicators are not specific for TCE. High levels of exposure in industrial settings may be detectable in the blood or urine for up to a week. In such a case, the Agency for Toxic Substance and Disease Registry recommends blood tests for CBC (complete blood count), glucose, and electrolyte. Other tests may include renal and liver function. Patients experiencing respiratory problems following

high exposure levels may undergo pulse oximetry, ABG (arterial blood gas) measurements, and chest radiography.

At the low levels of exposure seen at CRREL these days, medical tests might miss any indication of exposure to TCE. If detected, it would likely be difficult to distinguish exposure from the background, other chemicals producing similar test results, adverse health effects tied to lifestyle choices like smoking and diet, or different states of health among people.

## 21. Where can I go to get reliable information about TCE, health effects, and vapor intrusion?

Much has changed recently in the health assessment of TCE, and those changes have proven to be controversial. Reliable information comes from credible agencies such as USEPA, which led the way to the recent changes. Beware that some information obtained from the internet may not agree with the change, and may not be reliable or up to date. Be cautious of opposing viewpoints that do not offer peer reviewed studies or research.

EPA Glossary on risk assessment terminology – www.epa.gov/nata/gloss1.html

Online information about vapor intrusion may be found at the USEPA website for vapor intrusion at:

**www.epa.gov/oswer/vaporintrusion/.**

Information about toxic effects related to TCE may be found at:

**www.atsdr.cdc.gov/toxfaqs/tf.asp?id=172&tid=30.**

The USEPA Integrated Risk Information System (IRIS) file for trichloroethylene may be found at:

**www.epa.gov/iris/subst/0199.htm.**

The USEPA Toxicological Review and Appendices for trichloroethylene may be found at:

**www.epa.gov/iris/supdocs/0199index.html.**

The CRREL website provides information about TCE and the ongoing investigation at:

UPDATE WITH NEW ERDC CRREL LINK

This site will be updated as new information is available.

QUESTIONS?

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