Health Consultation

VAPOR INTRUSION AT
AMERICAN RED CROSS – OUTAGAMIE COUNTY CHAPTER

CITY OF APPLETON, OUTAGAMIE COUNTY, WISCONSIN

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

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Prepared By:

Wisconsin Department of Health Services
Under cooperative agreement with
The Agency for Toxic Substances and Disease Registry

Summary and Statement of Issues

During October, 2007, staff from the Appleton City Health Department and the Wisconsin Division of Public Health (DPH) visited the American Red Cross – Outagamie County Chapter (ARC-OCC) at 1302 E. Wisconsin Ave. to evaluate the potential for vapor intrusion. In January, 2008 DPH tested and screened for various volatile organic compounds (VOCs) in indoor air of the building. The results found tetrachloroethylene (PCE) well above health-based comparison values in air throughout the facility. The levels of PCE posed a *public health hazard* to workers and volunteers due to an unacceptable increased lifetime excess cancer risk. But workers and volunteers breathing PCE at these levels is not likely to cause non-cancer health effects associated with higher PCE exposures.

After receiving the January 2008 air sampling results DPH recommended the ARC-OCC take actions to reduce the levels of these compounds in the indoor air, including the installation of an active vapor mitigation system (typically used for radon vapors) to remove the vapors in soils around and beneath the basement. The ARC-OCC installed an active vapor mitigation system on April 30, 2008. DPH collected indoor and outdoor air samples one week after the installation of the system, and the concentrations of PCE were approximately 16 times lower. The levels, while still above screening levels, now pose *no apparent public health hazard* to the workers and volunteers. DPH expects the levels of PCE to continue to drop as the vapor mitigation system runs for a longer period of time. DPH plans to sample the indoor air at ACR-OCC again in the fall and winter to confirm the PCE and TCE levels.

Background

Site Description and History

In August 2006, the Wisconsin Department of Natural Resources (DNR) requested assistance from DPH to investigate possible vapor migration and intrusion into the indoor air of a Red Cross facility located on a former dry cleaning property (DNR Bureau for Remediation and Redevelopment Tracking System # 0245192316).

In 1998 the ARC-OCC moved into the newly constructed facility on the property that formerly contained a dry cleaning operation (Figure 1). The ARC-OCC installed a system of drain tiles and three sumps to keep the basement of the facility dry due to the very shallow groundwater (three to seven feet). The basement is finished space and contains a training room and some offices, as well as the facility's utilities.

Environmental investigations at the ARC-OCC show that groundwater and soils are contaminated with elevated levels of PCE and other chlorinated VOCs (McMahon 1999). Shallow groundwater is contaminated with PCE as high as 3,400 µg/l. The depth to groundwater at the site is generally between four to seven feet below the ground surface. Sub-surface soil borings detected PCE at levels up-to 13,000 µg/kg. Water samples in two of the three ARC-OCC sumps contained PCE as high as 170 µg/l and TCE 29 µg/l.

Figure 1: American Red Cross – Outagamie County Chapter
1302 E. Wisconsin Ave. Appleton, Wisconsin

Indoor Air Data

In response to the DNR request, DPH met at the ARC-OCC on October 30, 2007, with the Executive Director for the ARC-OCC, the DNR project hydrogeologist and the Environmental Consultant to discuss the potential for vapor migration and intrusion into the building. The extent of the soil and groundwater plumes as outlined by the consultant's data (McMahon 2006) were discussed along with the VOCs detected in the basement sumps and the fact that the ARC-OCC is not covered by the State of Wisconsin's Dry Cleaner Environmental Response Fund (DERF). After learning of the VOC contamination in the sump water, the director of the ARC-OCC arranged to have the sump crocks sealed by a plumber.

On January 24, 2008, DPH returned to the ARC-OCC and collected seven air samples using 6-liter evacuated SUMMA® canisters. DPH collected three indoor air samples: one each from the breathing zones of the first floor conference room, the basement training room and the basement volunteer office. One outdoor air sample was also collected from a snow-covered grassy area upwind to the west of the building as a background. Each canister's regulator and restrictor were adjusted to draw samples over a 1-hour period. Three grab samples were also collected from each of the sealed sump crocks by drilling a hole through the sump cover and installing tygon® tubing into the sump. The canisters were submitted to the Wisconsin State Laboratory of Hygiene (SLH) for analysis by gas chromatography and mass spectroscopy (GC/MS) following EPA method TO-15 (EPA 2002). PCE was detected in all air samples. The highest levels were detected in the sump crock headspace, with 2400 $\mu g/m^3$ present in the elevator room sump, 2200 $\mu g/m^3$ in the furnace room sump, and 480 $\mu g/m^3$ in the training room closet sump (Table 1). PCE was detected in the breathing zone of the indoor air at 240 $\mu g/m^3$ in the basement volunteer office, 180 $\mu g/m^3$ in the basement training room, and 150 $\mu g/m^3$ in the first floor conference

room. PCE was also detected at a much lower concentration in the outdoor sample at 2 µg/m^3 (Table 2).

Table 1: Sump Crock Head Space Sampling Results, January 24, 2008

Chemical	*Furnace Room*	*Elevator Room*	*Training Room Closet*	*Comparison Value**
cis-1,2-dichloroethylene	230	110	31	260
trans-1,2-dichloroethylene	17	4.4	0.70	260
tetrachloroethylene (PCE)	2200	2400	480	2.1
1,1,1-trichloroethane	<0.50	0.80	<0.50	22,000
trichloroethylene (TCE)	200	86	23	6.1
vinyl chloride	<0.40	<0.40	<0.40	280

All concentrations in µg/m^3
*Oak Ridge National Laboratory, Screening Levels for Chemical Contaminants (Regional Screening Levels) for indoor worker

Table 2: Indoor Air Sampling Results, January 24, 2008

Chemical	*Outdoor Air*	*Conference Room (1st floor)*	*Volunteer Office (basement)*	*Training Room (basement)*	*Comparison Value**
cis-1,2-dichloroethylene	<0.40	5.9	6.7	9.5	260
trans-1,2-dichloroethylene	<0.40	<0.40	0.5	<0.40	260
tetrachloroethylene (PCE)	1.9	150	240	180	2.1
1,1,1-trichloroethane	<0.50	<0.50	<0.50	<0.50	22,000
trichloroethylene (TCE)	1.0	5.9	7.0	13	6.1
vinyl chloride	<0.40	<0.40	<0.40	<0.40	280

All concentrations in µg/m^3
*Oak Ridge National Laboratory, Screening Levels for Chemical Contaminants (Regional Screening Levels) for indoor worker

During the January 24, 2008 site visit, DPH also screened the indoor and outdoor air and the sump crock headspace air with a photo-ionizations detector (PID). This detector is able to measure total VOCs in the single-digit, parts per billion range. The screening of the indoor air allowed DPH to identify indoor solvent sources or preferential vapor migration pathways in the building. Air screening of the sump crock head space detected VOC concentrations ranging from 174 ppb to 410 ppb. The levels detected in the indoor air breathing zone ranged between 400 to 420 ppb. The PID did not detect any VOCs in the outdoor air.

Based on the results of the initial air sampling, DPH recommended ARC-OCC take actions to reduce the levels of these compounds in the indoor air, including the installation of an active vapor mitigation system (typically used for radon) to remove vapors in soils around and beneath

the basement (DPH, 2008). The ARC-OCC installed an active vapor mitigation system on April 30, 2008.

On May 7, 2008, DPH returned to the ARC-OCC and collected four air samples using 6-liter evacuated SUMMA® canisters. DPH collected and the SLH analyzed three indoor air samples and one outdoor sample in the same locations as the January 24 sampling. Each canister's regulator and restrictor were adjusted to draw samples over an 8-hour period. PCE was detected at much lower levels than in the January air samples. The levels ranged from 7 μg/m^3 in the first floor conference room to 15 μg/m^3 basement volunteer office (Table 3). PCE was not detected in the outdoor background sample.

Table 3: Indoor Air Sampling Results, May 7, 2008

Chemical	*Outdoor Air*	*Conference Room (1st floor)*	*Volunteer Office (basement)*	*Training Room (basement)*	*Comparison Value**
cis-1,2-dichloroethylene	<0.40	<0.40	<0.40	<0.40	260
trans-1,2-dichloroethylene	<0.40	<0.40	<0.40	<0.40	260
tetrachloroethylene (PCE)	<0.70	7	15	14	2.1
1,1,1-trichloroethane	<0.50	<0.50	<0.50	<0.50	22,000
trichloroethylene (TCE)	<0.50	<0.50	<0.50	<0.50	6.1
vinyl chloride	<0.40	<0.40	<0.40	<0.40	280

All concentrations in μg/m^3

*Oak Ridge National Laboratory, Screening Levels for Chemical Contaminants (Regional Screening Levels) for indoor worker

Discussion

PCE Levels in Indoor Air

The levels of PCE and TCE found in the soil and groundwater beneath the ARC-OCC building, and in the indoor air of the building, demonstrate that vapor migration and intrusion into the indoor air is a completed pathway from the former dry cleaning operations at the site. The PCE levels found in January 2008 inside the ARC-OCC represented an approximate 1-in-1,000 theoretical excess lifetime cancer risk level for an indoor-worker setting and posed *a public health hazard* to the workers and volunteers in the building. The highest level of PCE in the work space of the ARC-OCC was 240 μg/m^3, which is approximately 100 times higher than the maximum target PCE level for an indoor-worker setting (2.1 μg/m^3) (Oak Ridge National Laboratory 2008). The target level is based on a 1-in-1,000,000 theoretical increased excess lifetime cancer risk. Studies of dry cleaner workers indicates there may be a connection between PCE exposure and increased risk of certain cancers, but the weight of the scientific evidence is not conclusive and PCE is not currently classified by EPA as a known human carcinogen (ATSDR 1997). The EPA is currently reviewing the toxicological assessment of PCE (EPA

June 2008). A draft document prepared by the National Center for Environmental Assessment is available for review. Despite EPA's current carcinogenicity status for PCE, DPH continues to rely on the inhalation unit risk previously developed and presented in the ORNL Screening Levels for Chemical Contaminants when estimating increased human cancer risk due to PCE exposures.

At very high concentrations and breathed by people for a long time, PCE in indoor air can cause adverse, non-cancer health effects (affecting the central nervous system, liver, and kidney), but the highest levels detected inside the ARC-OCC are not expected to cause such adverse, non-cancer health effects. The PCE level in January in the working space at the ARC-OCC was slightly above the EPA Reference Dose, yet slightly below the ATSDR Minimum Risk Level (MRL). The EPA Reference Dose for PCE is 0.01mg/kg/day. This dose was derived from studies that found a "no observed adverse effect level" (NOAEL) for laboratory animals exposed to PCE (EPA 2006). For a worker breathing indoor air with PCE at 240 $\mu g/m^3$, their daily PCE exposure would be 0.023 mg/kg/day, which is about two times above the Reference Dose. A Reference Dose is a value established by the EPA that is an estimate of the maximum daily, life-time exposure to a chemical that is not likely to cause harmful health effects. This Reference Dose was derived from laboratory studies that observed liver toxicity in mice and weight gain in rats when PCE doses exceeded 14 mg/kg/day. A safety factor of 1,000 was used to extrapolate this NOAEL for animals and derive a Reference Dose for humans. The maximum indoor air concentration of 240 $\mu g/m^3$ of PCE was less than the ATSDR chronic MRL of 300 $\mu g/m^3$. The chronic MRL was based on a study that observed unfavorable neurological responses in women who were exposed over a long term to PCE concentrations averaging 102,000 $\mu g/m^3$. At lower PCE concentrations of 1,300 $\mu g/m^3$ the study did not observe such adverse neurological effects in workers. In summary, a long term inhalation exposure to the level of PCE found in January at the ARC-OCC is not expected to result in non-cancer health effects.

It is important to note that PCE is commonly found in the indoor air of offices and homes, but the levels of PCE in the ARC-OCC prior to the installation of a vapor mitigation system are not typical for an office and are apparently coming from source(s) outside the building. A review of data on the concentrations of volatile organic compounds measured in the indoor air of North American homes and office buildings from 1990 to 2001 found the central tendency value of PCE for office buildings to be 0.47 ppb (3.2 $\mu g/m^3$) (Hodgson and Levin, 2003). The maximum concentration of PCE found in this review of office buildings not believed to be impacted by vapor intrusion was 3.8 ppb (26 $\mu g/m^3$). The maximum concentration found at the ARC-OCC in the basement volunteer office was 240 $\mu g/m^3$. This level is 63 times greater than the central tendency value and nine times greater than the maximum value found in this review of indoor air concentrations of PCE in office buildings.

TCE Levels in Indoor Air

The TCE levels found during the January sampling inside the ARC-OCC represented an approximate 1-in-500,000 theoretical excess lifetime cancer risk level for an indoor-worker setting and represented *a no apparent public health hazard* to the workers and volunteers in the building. The highest level of TCE in the work space of the ARC-OCC was 13 $\mu g/m^3$, which is only approximately two times higher than the maximum target TCE level for an indoor-worker

setting (6.1 μg/m^3) (Oak Ridge National Laboratory 2008). The target level for TCE is based on a 1-in-1,000,000 theoretical increased excess lifetime cancer risk. The TCE levels in the indoor air one week after the installation of the vapor mitigation system dropped below detection levels. Studies of workers in degreasing or dry cleaning operations indicates there may be a connection between TCE exposure and increased risk of certain cancers (leukemia), but the weight of the scientific evidence is not conclusive and TCE is not currently classified by EPA as a known human carcinogen (ATSDR 1997b). The EPA is currently reviewing the toxicological assessment of TCE (EPA June 2008). Despite EPA's current carcinogenicity status for TCE, DPH continues to rely on the inhalation unit risk previously developed and presented in the ORNL Screening Levels for Chemical Contaminants when estimating increased human cancer risk due to TCE exposures.

It is important to note that TCE is also commonly found in the indoor air of offices and homes, and the levels of TCE in the ARC-OCC are within the typical range for an office. A review of data on the concentrations of volatile organic compounds measured in the indoor air of North American homes and office buildings from 1990 to 2001 found the central tendency value of TCE for office buildings to be 14.8 ppb (9.7 μg/m^3) (Hodgson and Levin, 2003). The best estimate of the concentration in the indoor air of homes from this review was much lower, 0.07 ppb (0.37 μg/m^3). The maximum concentration found at the ARC-OCC was in the basement volunteer office at 13 μg/m^3. While this level is just above the central tendency value of indoor air concentrations of TCE in office buildings, once the active vapor mitigation system was installed and running, the levels of TCE in the ARC-OCC dropped below detection level. This suggests that the TCE levels formerly present in the indoor air of the ARC-OCC were apparently coming from a source outside the building.

Affect of Mitigation System Installation

Prior to the installation of an active vapor mitigation system, the workers and volunteers at the ARC-OCC breathed indoor air with elevated levels of PCE and TCE. The PCE and TCE vapors originate from the contaminated groundwater beneath the building. The workers and volunteers do not have direct contact with contaminated sub-surface soils nor are they drinking PCE or TCE contaminated groundwater. The concentrations of PCE found in the indoor air at ARC-OCC posed a *public health hazard* for the workers and volunteers because of an unacceptable theoretical excess lifetime cancer risk. The concentrations of TCE found in the indoor air at ARC-OCC presented a *no apparent public health hazard* for the workers and volunteers because of a very low increased excess lifetime cancer risk. The levels of PCE and TCE in the indoor air were not likely to cause non-cancer health effects associated with much higher PCE and TCE exposures. The past high PCE and TCE levels in the breathing zone of the ARC-OCC, the high concentrations in found groundwater under the building, the sump crocks water and air headspace demonstrate that vapor migration and intrusion to indoor air is a completed exposure pathway.

One week after the installation of a vapor mitigation system, the PCE levels dropped by a factor of 16. The lower levels, while still above screening levels, now pose *no apparent public health hazard* to the workers and volunteers due to a low increased risk of cancer. The TCE levels in the indoor air one week after the installation of the vapor mitigation system dropped below

detection levels. DPH expects the levels of PCE to continue to drop as the vapor mitigation system runs for a longer period of time. DPH collected these very early post installation samples to gather data on the rate at which such a system lowers indoor air concentrations. DPH plans to sample the indoor air at ACR-OCC again in the fall and winter.

Child Health Considerations

In communities faced with air, water, or food contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than are adults from certain kinds of exposure to hazardous substances. Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than are adults; this means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus adults need as much information as possible to make informed decisions regarding their children's health.

DPH recognizes that children can be especially sensitive to contaminants and has taken that into account when evaluating the PCE and TCE levels present at ARC-OCC. However, the volunteers and workers at ARC-OCC are adolescent to older adults and there are no young children who regularly spend time in the ARC-OCC.

Conclusions

- PCE levels detected in January, 2008, in the indoor air of the ARC-OCC prior to the installation of an active vapor mitigation system, posed a *public health hazard* for chronic exposure to the workers and volunteers due to an unacceptable increased excess lifetime cancer risk.

- The levels of PCE and TCE in the indoor air of the ARC-OCC are below the ATSDR Minimal Risk Levels for acute exposure for PCE and TCE and are not likely to cause non-cancer health effects.

- The levels of PCE and TCE found in the indoor air of the ARC-OCC, soil and groundwater beneath the building demonstrate that vapor migration and intrusion into the indoor air is a completed pathway from the former dry cleaning operations at the site.

- The ARC-OCC installed an active radiation mitigation system on April 30, 2008. One week later, the levels of PCE detected dropped by a factor of 16, and TCE levels dropped below the SLH detection limit. The lower levels of PCE, while still above screening levels, now pose *no apparent public health hazard* to the workers and volunteers.

Recommendations

- DPH recommended that the ARC-OCC take actions to reduce the levels of PCE and TCE in the indoor air, including installing an active vapor mitigation system to remove the vapors in soils around and beneath the basement. ARC-OCC subsequently installed an active vapor mitigation system on April 30, 2008.
- While the indoor air samples collected one week after the installation of a mitigation system resulted in lowered levels of PCE and non-detect levels of TCE, DPH believes that continued operation of the system and the addition steps recommended below should be undertaken to further reduce the levels in the ARC-OCC.
- DPH recommends that the sump crock and sealed lids be opened, inspected and carefully resealed every three years by a certified plumber. The sump crock lids should have the existing mini-vents removed.
- An inspection should be undertaken of the basement floor and walls looking for any cracks or breaks. Any found should be sealed in an appropriate manner.
- Three to six months after these actions are taken collect another round of air samples to evaluate the effectiveness of these actions.

Public Health Action Plan

- DPH responded to a request from DNR to investigate the potential for vapor migration and intrusion into the indoor air of ARC-OCC.
- DPH will conduct additional rounds of indoor air sampling at the ARC-OCC this fall and winter to monitor the reductions in the levels of PCE and TCE since the installation of an active vapor mitigation system.
- DPH will continue to communicate and collaborate with the staff at the ARC-OCC, the DNR and the Appleton City Health Department to address public health questions and concerns relating to the former dry cleaning operations at the site.

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Certification

This Health Consultation for the American Red Cross – Outagamie County Chapter was prepared by the Wisconsin Department of Health Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with the approved methodology and procedures existing at the time the Health Consultation was begun. Editorial review was provided by the cooperative agreement partner.

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The Division of Health Assessment and Consultation, ATSDR, has reviewed this Health Consultation and concurs with the findings.

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