Vapor Intrusion

Will Elcoate
Product Manager  Air

November 18th 2008
Why is vapor intrusion a problem?

- Toxic and/or carcinogenic compounds
- Exposure risk is by inhalation (Cancer and non-cancer risk)
- Long term, non-voluntary “constant” exposure
- Exposure pathway that needs to be addressed

**VI exposure risk via inhalation.**
Typical adult non-voluntarily inhales 20,000 liters per day.  
- Voluntarily drinks 2 liters per day of water.
On average people spend 90% of their time in-doors
Vapor Intrusion is the migration of volatile chemicals from the subsurface into overlying or adjacent buildings.

www.epa.gov/correctiveaction/eis/vapor.html
**Vapor Intrusion Timeline**

**ITRC Publishes Vapor Intrusion Guidance**
NY Publishes Final Guidance, Re-opens 1400 NFR Sites

USEPA GOAL: Reduce risk at 374,000 contaminated sites, including Vapor Intrusion

USEPA West Coast and UMass workshops

USEPA VI Workshops: Atlanta, Dallas, SF

OSWER replaces 2001 RCRA Guidance

RCRA Forum

Redfield Rifle Scopes Site and CDOT Site

J&E model published

- **1970**
  - 1976 - 1986: Core environmental regulations enacted
    - RCRA, TSCA, CERCLA, HSWA, SARA

- **1970s** FOCUS ON BUILDING AIR QUALITY

- **1980**

- **1980**

- **1990**

- **1990**

- **1991**

- **1991**

- **1995**

- **1995**

- **1995 - 2000**
  - States begin addressing Vapor Intrusion: MA, CT, MI

- **2000**

- **2000 - 2005**
  - Many States Publish VI Guidance
  - 2008 EPA Publishes Attenuation Factor Database

- **2000 - 2008**

- **2000**

- **2000**

- **2002**

- **2002**

- **2003**

- **2003**

- **2004**

- **2004**

- **2005**

- **2005**

- **2006**

- **2006**

- **2007**

- **2007**

- **2008**

**Modified from: M. Traister, O’Brien & Gere**
EPA (2002)
Focused on the appropriateness of exits
Single line of evidence can be used to screen out sites
(i.e., make a reliable VI determination)

ITRC (2007)
Focused on collection of appropriate data
Refers to regulatory guidance for exits
Refers to regulatory guidance for all policies

March 4th, 2008 U.S. EPA’s Vapor Intrusion Database:
Preliminary Evaluation of Attenuation Factors
Office of Solid Waste
U.S. Environmental Protection Agency
Washington, DC 20460

Update & Status of USEPA’s Vapor Intrusion Guidance
AEHS West Coast Conference
San Diego, Calif.
March 13, 2008
Presented by:
Henry Schuver Dr. PHd, US EPA – OSW
ITRC is a state-led coalition includes industry, stakeholders to achieve regulatory acceptance of environmental technologies.

2005 Vapor intrusion Team formed; 19 of 46 States participated with API, ASTM, EPA and industry Participants publish two documents in January 2007.

Uses the concepts of: Conceptual Site Model, Multiple lines of evidence & Weight of evidence

Provides a Vapor Intrusion (VI) “Tool Box” Covers in an iterative Stepwise (13) process VI evaluations from Investigation through Mitigation.

Does not address: Compounds, Screening or Risk levels

www.itrcweb.org/vaporintrusion
States with published definitive guidance

States with less than that.....
## Table 3. Residential Screening Levels for Selected VOCs

<table>
<thead>
<tr>
<th>State</th>
<th>Benzene</th>
<th></th>
<th></th>
<th>TCE</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>PCE</th>
<th></th>
<th></th>
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<tbody>
<tr>
<td>Alaska</td>
<td>5</td>
<td>3.1</td>
<td>0.31</td>
<td>5</td>
<td>0.22</td>
<td>0.022</td>
<td>5</td>
<td>8.1</td>
<td>0.81</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>California</td>
<td>NA</td>
<td>36.2</td>
<td>0.084</td>
<td>NA</td>
<td>528</td>
<td>1.22</td>
<td>NA</td>
<td>180</td>
<td>0.41</td>
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<td></td>
<td></td>
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<td>Colorado</td>
<td>15</td>
<td>NA</td>
<td>0.25</td>
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<td>NA</td>
<td>0.016</td>
<td>5</td>
<td>NA</td>
<td>0.51</td>
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<tr>
<td>Connecticut</td>
<td>130</td>
<td>2,490</td>
<td>3.3</td>
<td>27</td>
<td>752</td>
<td>1</td>
<td>340</td>
<td>3,798</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Indiana</td>
<td>95-850</td>
<td>250 - 1400; 25 - 140°</td>
<td>2.5</td>
<td>4.6 - 700</td>
<td>120 - 2000; 2 - 200°</td>
<td>1.2 - 4.1</td>
<td>7.4 - 1100</td>
<td>320 - 5200; 32 - 520°</td>
<td>3.2 - 10</td>
<td>0.04</td>
<td></td>
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<tr>
<td>Louisiana</td>
<td>2,900</td>
<td>NA</td>
<td>12</td>
<td>10,000</td>
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<td>59</td>
<td>15,000</td>
<td>NA</td>
<td>110</td>
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<td>Maine</td>
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<td>10°</td>
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<td>NA</td>
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<tr>
<td>Massachusetts</td>
<td>2,000</td>
<td>NA</td>
<td>0.3</td>
<td>31</td>
<td>NA</td>
<td>1.37</td>
<td>50</td>
<td>NA</td>
<td>0.04</td>
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<tr>
<td>Michigan</td>
<td>5,600</td>
<td>150</td>
<td>2.9</td>
<td>15,000</td>
<td>700</td>
<td>14</td>
<td>25,000</td>
<td>2,100</td>
<td>42</td>
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<tr>
<td>Minnesota</td>
<td>NA</td>
<td>1.3-4.5</td>
<td>1.3-4.5</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
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<td>NA</td>
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<td>New Hampshire</td>
<td>2,000</td>
<td>95</td>
<td>1.9</td>
<td>50</td>
<td>54</td>
<td>1.1</td>
<td>80</td>
<td>68</td>
<td>1.4</td>
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<td>2</td>
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<tr>
<td>Ohio</td>
<td>14</td>
<td>31</td>
<td>3.1</td>
<td>--</td>
<td>122</td>
<td>12.2</td>
<td>11</td>
<td>81</td>
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<tr>
<td>Oklahoma</td>
<td>5</td>
<td>31</td>
<td>0.27</td>
<td>5</td>
<td>0.17</td>
<td>0.017</td>
<td>5</td>
<td>0.33</td>
<td>0.33</td>
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<td>Oregon</td>
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<tr>
<td>Pennsylvania</td>
<td>3,500</td>
<td>NA</td>
<td>2.7</td>
<td>14,000</td>
<td>NA</td>
<td>12</td>
<td>42,000</td>
<td>NA</td>
<td>36</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**Notes:**
1. Units are µg/L for groundwater and µg/m³ for soil gas and indoor air.
2. See individual state guidance documents for additional information, including limitations and exceptions.
3. Trigger or action levels for mitigation based on indoor air concentrations may be higher than the screening levels shown.

* Second range of values shown is for sub-slab soil gas.
* Chronic exposure value.
Brownfields Technology Primer: Vapor Intrusion Considerations for Redevelopment (EPA 542-R-08-001).

This primer is designed for land revitalization stakeholders concerned about vapor intrusion, including property owners, municipalities, and real estate developers. It provides an overview of the vapor intrusion issue and how it can affect redevelopment. It also summarizes techniques for quickly and cost effectively assessing the potential for vapor intrusion, as well as techniques for mitigating it. The topics covered will familiarize stakeholders with options for addressing vapor intrusion to help them communicate with their project contractors and consultants (March 2008, 48 pages).

View or download at
http://brownfieldstsc.org/vaporintrusion
http://brownfieldstsc.org/newpublications.cfm?tabS=2
ASTM Standard E2600 – 08 March 3rd. 2008
“Standard Practice for the Assessment of Vapor Intrusion into Structures on Property Involved in Real Estate Transactions”

**Objectives**—Objectives guiding the development of this practice are:

- To synthesize and put into writing good commercial and customary practice for conducting a *Vapor Intrusion Assessment* on a property involved in a *real estate transaction*
- To supplement a *Phase I environmental site assessment (ESA)* conducted in accordance with Practice E 1527,
- To ensure that the process for assessing vapor intrusion is practical and reasonable
- To provide an industry standard for a *VIA* on a property involved in a *real estate transaction*.

Maybe purchased at; [http://www.astm.org/Standards/E2600.htm](http://www.astm.org/Standards/E2600.htm)
Four (4) Tier Process

Tier 1 Determine if there’s a VIC or p-VIC condition
  *may be considered a supplement to a Practice E 1527 Phase I ESA*

Tier 2 investigate/model/screening tools
  Applies semi-site specific numeric screening criteria to existing or newly collected soil, soil gas and/or groundwater testing results to assess whether or not a pVIC still exists.
  Tier 2 has two data collection components: one non-invasive and one invasive.

Tier 3 VI Pathway Assessment
  Evaluations should utilize the following general process:
  ~ Identify the desired endpoint
  ~ Identify applicable regulatory standards, requirements, and models, or other evaluation criteria to be utilized
  ~ Identify and collect needed data
  ~ Evaluate data to determine if a VIC exists.

Tier 4 Pre-emptive remediation

VIC “Vapor Intrusion Condition”
Tier 4 Pre-emptive remediation

Institutional controls (ICs)

Legally enforceable conditions placed on a property;
• Restrictive covenants, zoning and land use restrictions

Engineering Controls

• Vapor intrusion mitigation systems, Passive or active
• Barriers and venting that block the migration of vapors
• Pressurization of building interiors or indoor air treatment systems
U.S. Green Building Council (www.usgbc.org) founded in 1993 (501(c)(3) non-profit)

- Leadership in Energy and Environmental Design (LEED) rating system launched in 1998
- LEED-APs (~40,000)

“Green Building” Rating system
Level of Green Standard
Level 1 – Certified Level 2 – Silver Level 3 – Gold Level 4 – Platinum

Air Testing after construction and before occupancy, conduct baseline IAQ tests
- Formaldehyde 0.05 ppm
- Particulates (PM10) 50 μg/m3
- Total VOC 500 μg/m3
- 4-Phenylcyclohexene (4-PCH) 6.5 μg/m3
- (only required is styrene butadiene rubber (SBR) latex)
- Carbon Monoxide 9 ppm

May 2007 AIHA “The Synergist” magazine article titled LEED and the Industrial Hygienist: Another Approach to Protect Worker Health
2002 OSWER Draft Guidance
In Table II lists 114 Compounds of Potential Concern (COPC’s)
• VOC’s Semi- VOC’s & Metals

Compounds of Potential Concern are determined by:
• Conceptual Site Model for the site, use historical impacts
• State VI Guidance

Reporting Limits come from:
• Guidance, screening tables by Federal, EPA or State agencies
• Soil Gas, Residential / Commercial Screening levels, MRL’s & RBCs

Sample Collection & Analysis is driven by the data use;
• What am I going to do with the Data?
• Is this for screening or definitive data
Mobile labs / Passive Monitors/ Laboratories
• Definitive Data: NELAC Approved Laboratory / Certified Media

Update February 22 2004:
USER’S GUIDE FOR EVALUATING SUBSURFACE VAPOR INTRUSION INTO BUILDINGS
TO-15 Analytical Overview

For Definitive Data, TO15 is the Typical Method

Whole Gas sample

Sorbent Traps

Cold Trap

GC/ MS

TCE @ 0.017 μg/m3 RBC
8 pg TCE for 500 mL sample
(EPA current screening level 1μg/M3)
Factors affecting VI Data

http://www.itrcweb.org/gd_VI.asp

List of Potential Sources of Variability

- Barometric pressure fluctuations
- Surface cover
- Preferential pathways
- Soil moisture content & permeability
- Building depressurization
  Seasonal effects: Advection
- Biodegradation
- Geologic heterogeneity
- Indoor Background
- Ambient Background
Sub-surface Spatial Variability

EPA Study

Sub-Slab Concentrations

<table>
<thead>
<tr>
<th>Compound</th>
<th>Probe A</th>
<th>Probe B</th>
<th>Probe C</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,1,1-TCA</td>
<td>76</td>
<td>542</td>
<td>52</td>
<td>50</td>
</tr>
<tr>
<td>1,1-DCE</td>
<td>64</td>
<td>480</td>
<td>31</td>
<td>40</td>
</tr>
<tr>
<td>TCE</td>
<td>17</td>
<td>189</td>
<td>31</td>
<td>17</td>
</tr>
<tr>
<td>cis-1,2-DCE</td>
<td>1.4</td>
<td>45</td>
<td>9.5</td>
<td>4.5</td>
</tr>
</tbody>
</table>
Temporal Variability of Vapor Transport

Variation in pressure differentials between inside the building and sub-slab can cause vapors to travel in both directions over time.

Differential pressure between indoors & Sub-slab can be measured

If sampling Indoor air; Always take Indoor air, Sub-slab and Ambient background samples concurrently.
Sources of Background Indoor Air Contamination

Common Household Sources of Background Indoor Air Contamination

<table>
<thead>
<tr>
<th>Compound</th>
<th>Source: J. Boyer, NJDEP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetone</td>
<td>Formaldehyde</td>
</tr>
<tr>
<td>Benzene</td>
<td>n-Heptane</td>
</tr>
<tr>
<td>Bromomethane</td>
<td>n- Hexane</td>
</tr>
<tr>
<td>2-Butanone (MEK)</td>
<td>Methylene chloride</td>
</tr>
<tr>
<td>Chlorobenzene</td>
<td>Methyl isobutyl ketone</td>
</tr>
<tr>
<td>Chloroethane</td>
<td>Methyl tert butyl ether</td>
</tr>
<tr>
<td>Chloroform</td>
<td>Styrene</td>
</tr>
<tr>
<td>Cyclohexane</td>
<td>1,1,2,2-Tetrachloroethane</td>
</tr>
<tr>
<td>1,4-Dichlorobenzene</td>
<td>Tetrachloroethene (PCE)</td>
</tr>
<tr>
<td>Dichlorodifluoromethane</td>
<td>Toluene</td>
</tr>
<tr>
<td>1,1-Dichloroethane</td>
<td>1,1,1-Trichloroethane</td>
</tr>
<tr>
<td>1,3-Dichloropropene</td>
<td>Trichloroethene (TCE)</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>Xylenes, total</td>
</tr>
</tbody>
</table>

Important:

Conduct a Building survey before Sampling

http://www.state.nj.us/dep/srp/guidance/vaporintrusion/
Chemical Information Sources

http://householdproducts.nlm.nih.gov/
http://webbook.nist.gov/chemistry/name-ser.html
http://www.atsdr.cdc.gov/
Soil Gas Sampling

Soil Gas/Sub Slab Sampling Protocols:

• After installation of probes (>24 hrs. permanent), purge one to three volumes
• Flow rates for both purging and collecting must not exceed 0.2 liters per minute
• Samples must be collected, using conventional sampling methods in certified clean containers (e.g., Summa® canisters if analyzing by using EPA Method TO-15)
• A sample size depends upon the volume of sample required to achieve minimum reporting limit requirements
• A tracer gas (e.g., helium, butane, or sulfur hexafluoride) must be used when collecting soil vapor samples

Other States have included, Isobutylene, Isopropyl Alcohol (IPA)
Soil Porosity

Use a flow restrictors/ flow controllers maximum flow rate of 200 mls per minute

http://www.api.org/ehs/groundwater/lnapl/soilgas.cfm
Ambient / Indoor Air entering the probe
Through seal leakage during sampling may represent a significant dilution of the sample.
"In Field" Leak detection

Leak check procedure /Tracer Gases:

~ Use a portable monitoring device to analyze for the tracer prior to and after sampling for the compounds of concern

~ Or, consult with your lab regarding ability to analyze for the tracer compound

~ If high concentrations (> 5%) of tracer gas are observed in a sample, the probe seal should be enhanced to reduce the infiltration of ambient air

http://www.ashtead-technology.com/us/

NYSDOH’s Draft VI Guidance
February 2005
Draft

Standard Operating Procedure (SOP) for Installation of Sub-Slab Vapor Probes and Sampling Using EPA Method TO-15 to Support Vapor Intrusion Investigations

Dominic DiGiulio, Ph.D.
U.S. Environmental Protection Agency
Office of Research and Development
National Risk Management Research Laboratory
Ground-Water and Ecosystem Restoration Division
Ada, Oklahoma

phone: 580 436 8605
e-mail: digiulio.dominic@epa.gov
Field Leak Check testing

Quantitative proof of sample integrity in the field

Concurrent in Indoor Air Sample (elevated)

Helium cylinder

Probe Installation Enclosure

Peristaltic pump for purging

Sub-Slab sample Canister

Sub-Slab Probe

Field Helium Meter
Vapor Intrusion

- Risk & Liabilities are still unclear
- Guidance from the EPA, States and Agencies continue to be published and updated
  Soil Gas Screening verses Indoor Air.
- Best Practices for Vapor Intrusion Pathway investigations are still developing, engage experience professionals
- Empirical Data reported shows that Background Sources, Site Conditions and field sampling have a significant impact
Questions?

Air Program

WILL ELCOATE
Product Manager - Air
Tel 708.261.8355
william.elcoate@testamericainc.com

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Town is a time bomb!
It’s sitting on sea of gasoline — and could blow up at any minute!

It’s a town that could explode at any minute!
The 1,700 residents of Hartford, Ill., are sitting on a ticking time bomb — because the whole town rests on an underground pool of close to four MILLION gallons of gasoline leaked from refinery pipes.

At any moment, a flint match or even a spark could ignite the enormous gasoline fumes. The village has even put up street signs warning drivers not to leave their cars running. It’s no empty threat — fire has already erupted at two houses when they were turned on.

A year ago, the house of Robert J. and Janet Ferris burned down. Ferris had built and lived in for 25 years. The gas company had not been notified, and the fumes had piled up.

“According to the fire department, the gas fumes entered the basement and were ignited by our furnaces,” said Ferris, who was home with his wife, her mother and a neighbor at the time. “The house was set on fire and destroyed by the blast and gas lighter than air.”

“Some people living with the terror of the gas fumes, but it’s especially frightening to Police Officer Doug Reed and his wife, Nora, whose house is close to the left.”

“Fumes in the basement were ignited by the water heater,” Reed said.

“Turn off the basement was on fire. We were able to call the police and the fire department, and they responded quickly.”

“Even the dirt burns!”

Deadly danger. This sample of the town’s soil is so hot it burns through the newspaper. The town is a time bomb, and anyone who enters it is at risk.

The town is a time bomb in Hartford, Ill., and it’s sitting on a sea of gasoline. The town is a ticking time bomb, and it could explode at any minute. The town is a time bomb, and it’s sitting on a sea of gasoline. The town is a ticking time bomb, and it could explode at any minute.

Power keg: The town of Hartford, Ill., is sitting on a ticking time bomb, and it could explode at any minute. The town is a time bomb, and it’s sitting on a sea of gasoline. The town is a ticking time bomb, and it could explode at any minute.

Parliament of Public Health, a group that deals with public health, has called for an investigation of the town, and the town is a time bomb, and it’s sitting on a sea of gasoline. The town is a ticking time bomb, and it could explode at any minute.

Cindy Plumb, a geologist with the Illinois Environmental Protection Agency, said the town is a time bomb, and it’s sitting on a sea of gasoline. The town is a ticking time bomb, and it could explode at any minute. The town is a time bomb, and it’s sitting on a sea of gasoline. The town is a ticking time bomb, and it could explode at any minute.