Water Pipe Repair Can Cause Toxic Air

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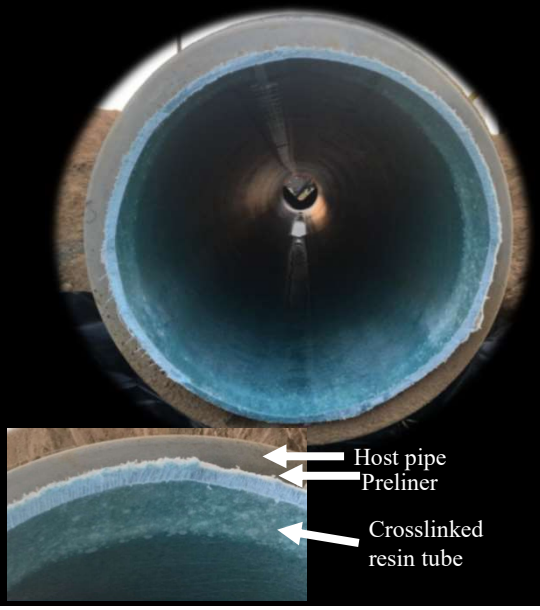
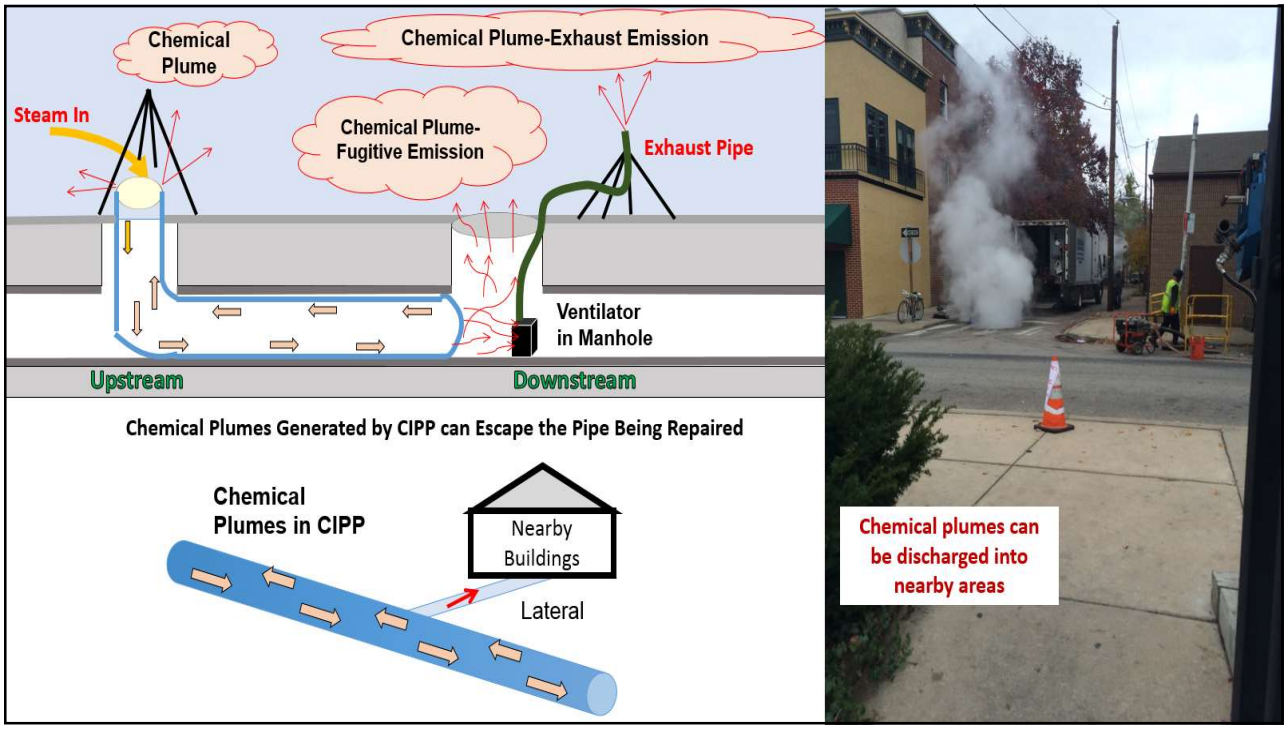
Today, Cured-in-Place-Pipe (CIPP) is used to repair 50% of all water pipes in the USA

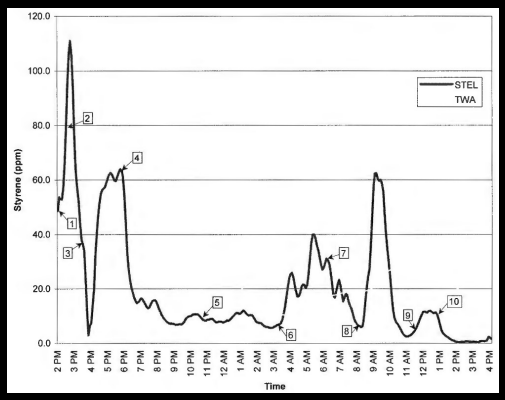
Trenchless technology: "No Dig" "No Excavation"
Resin impregnated tube hardened in a broken pipe
Curing method: Hot water, Steam, UV light
Deliberate curing time: Hours to many days





Incident Location	Styrene	Description of Events from Reference
West Lafayette, IN (Whelton 2016)	nr	Fumes entered office building through floor drains; doors opened to ventilate; no fire department called; contractor said just odor and not harmful
Good Hope, IL (Langhout 2016)	nr	Steam filled the post office 4 different times; no fire department called; lateral not plugged allowed chemical plume to enter building; blew off toilet
Montreal, Québec (Gagnon 2015)	nr	Fumes stayed in building for 1 month. Installers claimed styrene trapped underground and drifted into house. Installers installed blowers. After the 2nd month (1 month of ventilation) odor went away.
Buffalo Grove, IL (Andrews & Johnson 2015)	nr	Neighbors reported that they became nauseated and dizzy from chemical smell in their homes. One resident reported short of breath and headache. Another resident went to hotel due to the severe smell in their homes. They were repulsed, groggy, and confused.
Lincoln, NB (Fili 2015)	nr	Several homes evacuated; fire department called
Antigo, WI (Linder 2015)	nr	Illness symptoms reported; Whistling heard in drain inside building
Rensselaer, NY (Gagnon 2015)	nr	Chemical seeped to residential homes from sewer CIPP lining neighborhood displaced, residents reported that styrene permeated the clothing in their drawers, closets, and couches
Prairie Village, KS (Braun 2014)	nr	Smell of superglue in house, headaches and nostrils burning; utility contacted and told resident vapors nontoxic. Windows and doors opened for ventilation, but odor remained. County did not investigate and told resident chemicals were nontoxic.
Baltimore, MD (Ashton 2014)	nr	Resident evacuated house after detecting odor and experiencing chemical exposure symptoms; sought medical attention; Odors got stronger when it rained.
Ottawa, CN (Bauer 2012)	nr	Odors detected kilometers from worksite
Fayetteville, NY(Doran 2012)	nr	Odors permeated into nearby residences; residents complained and evacuated their homes
Brisbane, AUS (Woods 2012)	nr	Odors detected and exposure lasted 5 days in home; Health department investigated and demanded home be decontaminated; Pets died.
Birmingham, UK (Brody 2011)	nr	Six people and five students and a staff from high school were taken to hospital after the smell from sewer repair work made them sick.
Worcester, MA (Dayal 2011)	60 - 70	Fumes caused daycare center evacuation; headaches reported; emergency responders called to site
Minnesota (Marohn 2011)	nr	Odor caused building evacuations
Southfield, MI (Banovic 2011)	nr	Hazardous materials response team (HAZMAT) responded; vapors from nearby CIPP operation entered school ventilation system; building evacuated; children transported to hospital for chemical exposure symptoms
Saugus, MA (Tempesta 2011)	nr	Firefighters ordered evacuation of elementary school because of strong odor; dizzy and light-headed symptoms reported
Pittsburgh, PA (Hayes & Biedka 2011)	nr	Elementary and high school students were evacuated for fear of gas leak; odors from nearby CIPP operation were the cause
Birmingham, UK (Pub. Health England 2011)	20 - 200	Odor detected. Residences evacuated at contractors recommendation. Contractor did not disclose styrene present in homes above health limits until days after health agency involved.
Helena, MT (Banks 2010)	nr	Fire department evacuated affected building because of complaints of strong odors, nausea, and headaches
Arlington, VA (ARLnow.com 2010)	nr	Nearby CIPP installation caused odor; fire department responded
Pittsburgh, PA (WPXI-TV 2009)	nr	Firefighters evacuated apartment buildings; initially suspected cyanide gas, but styrene was ultimately detected from nearby CIPP
Somerset, United Kingdom (Wills 2007)	nr	Foul CIPP styrene odor permeated into residence through drain because of nearby installation
Brooklyn, NY (Lysiak 2007)	nr	Foul CIPP styrene odor permeated into buildings through drain because of nearby installations
Ottawa, CN (Bauer & McCartney 2004)	20, 115	Venting determined to be necessary to prevent air backup into nearby residences/ buildings
Alexandria, VA (Gowen 2004)	500	HAZMAT team responded because of styrene vapor backup into nearby buildings; illness symptoms reported
Milwaukee, WI (ATSDR 2004)	0.01 - 0.32	An office building that a large diameter sewer line was located under an old brewery building. All occupant complained about the strong odor. US federal health agency investigated. At least 11 employees were away from their work location for some portion of 17 days.
Toronto, CN (City of Toronto, 2001)	3.2	Eight houses were investigated but only two houses showed styrene due to traps engineered to be dry

Only 4 CIPP air monitoring studies have been conducted in the past 16 years



Bauer (2004)

A Report on the Monitoring of Styrene in Toronto Homes During the Cured in Place Pipe (CIPP) Process for Sewer Pipe Rehabilitation by Insituform

PROJECT NO. 041-6742

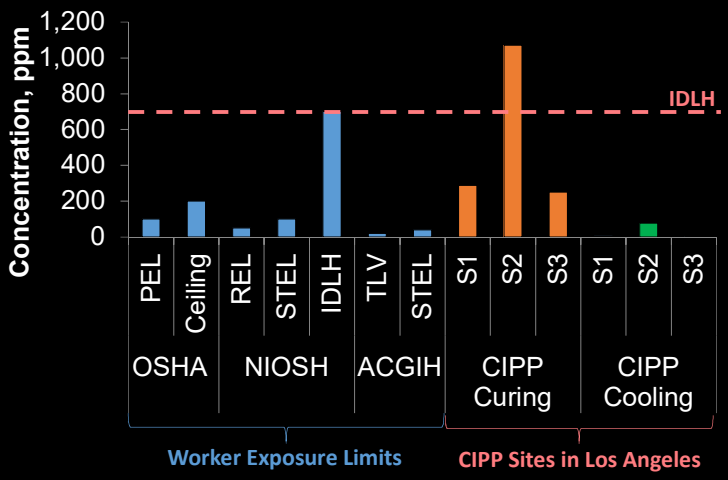
Prepared for
Toronto Works & Emergency Services
2700 Eglinton Avenue West
Toronto, Ontario
M6M 1V1

AirZone, Inc. (2001)

ATSDR (2005)

2015, Styrene Exiting CIPP Sewer Manhole Exceeded the NIOSH IDLH

IDLH: a concentration from which a *worker* could escape without injury or without irreversible health effects in the event of respiratory protection equipment failure



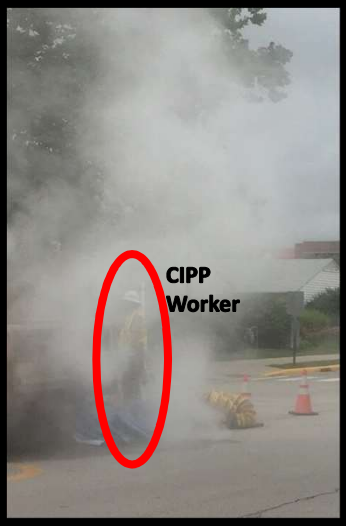
Adjari (2016)

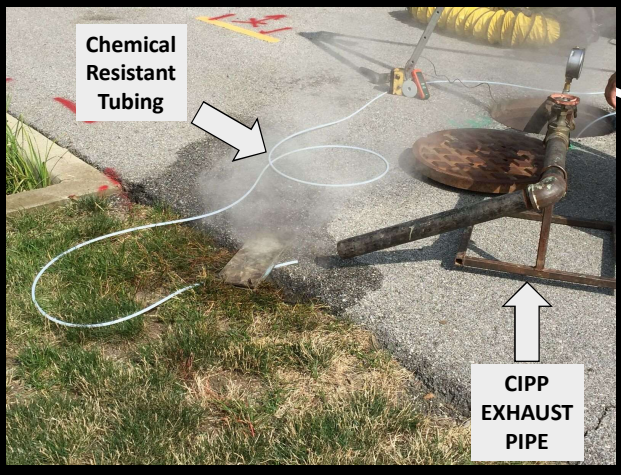
The Goal of this Study

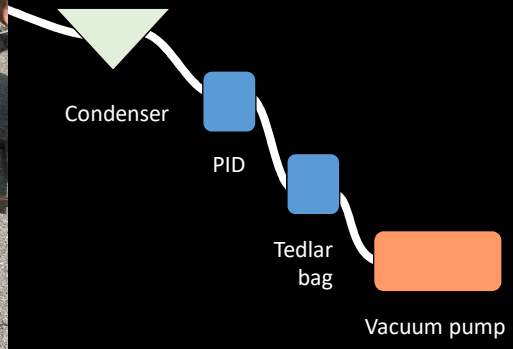
To better understand materials emitted from a CIPP sewer pipe and stormwater pipe repair installation and their potential toxicity

Objectives

1) Conduct air sampling and analysis for an Indiana CIPP sewer pipe repair site.
2) Characterize the raw materials, materials emitted, and their magnitudes.
3) Evaluate condensate toxicity to mouse lung cells.
4) Determine any worksite safety issues.

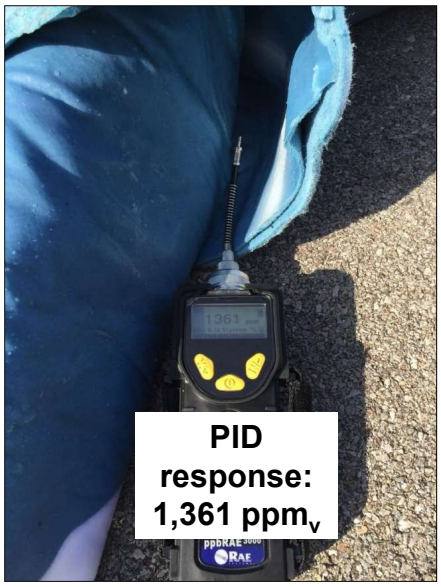






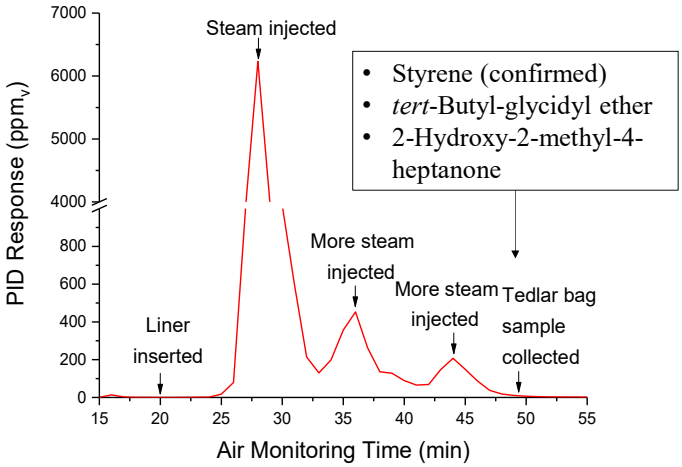
Methods: Conducted air sampling in the field at the exhaust pipe located at a CIPP sewer pipe repair site

Methods: Sample preparation and quantification of chemicals inside uncured resin tubes



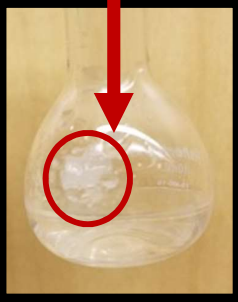
Before uncured resin tube was cured

Results: Chemicals were emitted from the uncured resin tube *before* installation and from the downstream manhole *during* installation

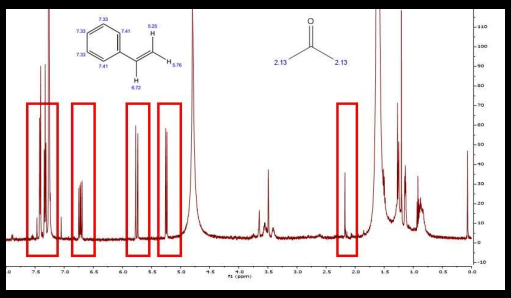


Materials in the white chemical plume were captured and the condensate was found to be a multi-phase mixture

1. Organic vapor
2. Water vapor
3. Particulate (condensable vapor, partially cured resin)
4. Liquid droplets (water, organics)



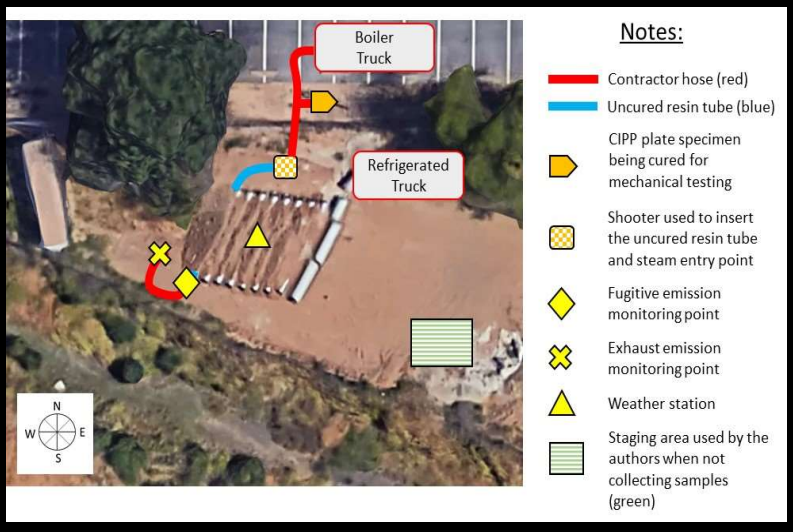
^{1}H NMR



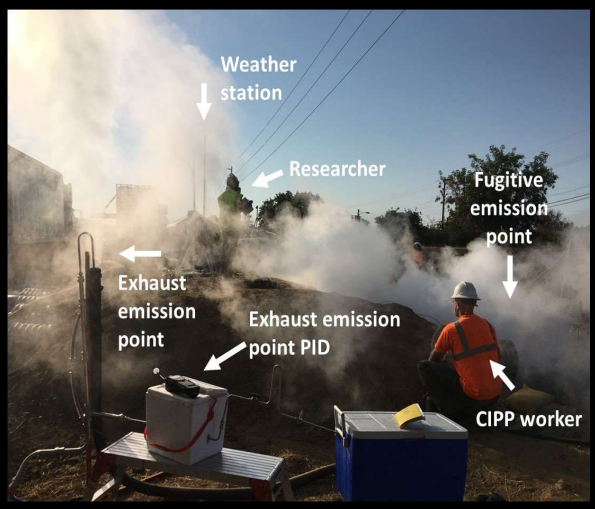
5 CIPP Installations in California were Monitored

Resins Evaluated
AOC: Styrene based
EcoTek: Non-styrene

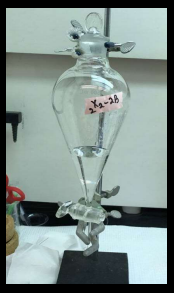
Sites
AOC Resin: 1,3,4,5
EcoTek Resin: 2



Methods: Fugitive and exhaust emissions are shown for one CIPP installation in California



Methods: To extract chemicals from the 'condensate', a liquid-liquid extraction method was developed

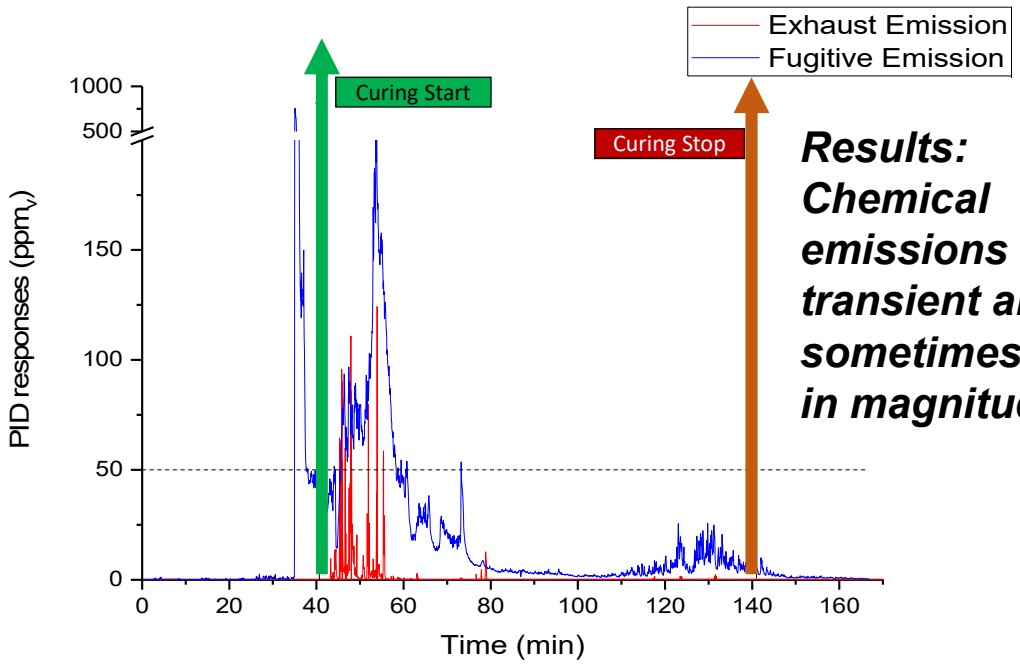


3.7 ml of extractant was obtained

Methods: To assess condensate cytotoxicity to animal lung cells, the MTT assay was used

- Mouse alveolar macrophages cell
- Mouse alveolar type II cell

Cells were exposed to condensates diluted to 10, 100, and 1000 ppm styrene for 24 h.

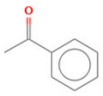


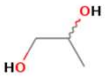
Results: Chemical emissions were transient and sometimes high in magnitude

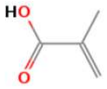
Results: Comparison of AOC vs EcoTek resin condensate composition

Chemical	Retention Time	Low VOC Resin	VOC Resin
Amylene hydrate	2.031	×	×
2-Butanone, 3-methyl-	2.149	×	×
1-Pentanol	3.84		×
2-Propenoic acid, 2-methyl-	4.533-4.66	×	
Phenylethyne	6.455		×
Cumene	7.841	×	×
**Benzaldehyde	8.064	×	×
*Phenol	8.46		×
*Acetophenone	9.81	×	
LINALOOL L	10.293		×
*Benzoic acid	11.138	×	×
Benzoic acid, ethyl ester	11.297		×
Triethylene glycol monobutyl ether	11.512	×	
Styrallyl Acetate	11.596		×
*4-tert-butyl-Cyclohexanol	11.693, 11.842	×	
TRIPROPYLENE GLYCOL 3	13.045	×	
Phenyl tert-butyl ketone	14.084	×	
**BHT	15.3	×	×
*1-Tetradecanol	16.836	×	×
**Tripropylene Glycol Diacrylate	17.531, 17.645, 17.724	×	
*Dibutyl phthalate	19.409	×	×
Di(2-ethylhexyl)adipate	22.62, 22.84	×	×

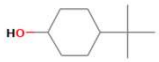
TICs Detected in EcoTek Resin Condensate:

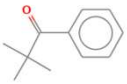
Acetophenone 

Tripropylene Glycol 3 

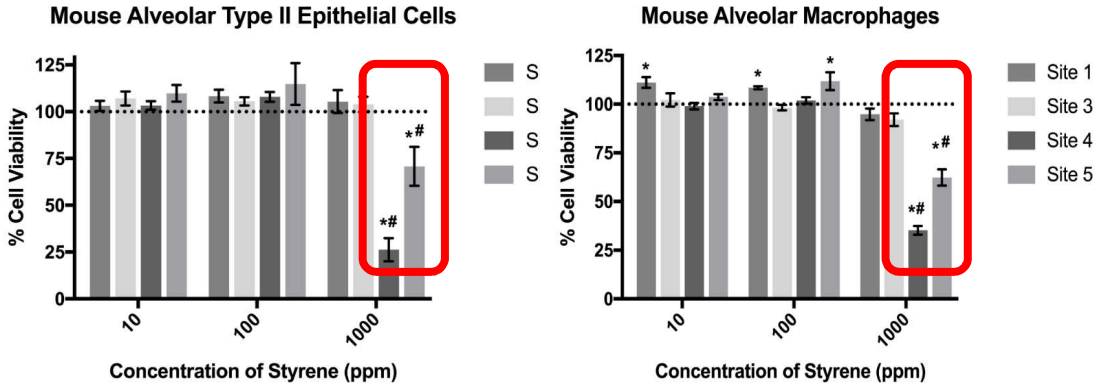
2-Propenoic acid, 2-methyl- 

Triethylene glycol monobutyl ether 

4-tert-butyl-Cyclohexanol 

Phenyl tert-butyl ketone 

Results: Cell viability changes were detected for some, but not all, condensates



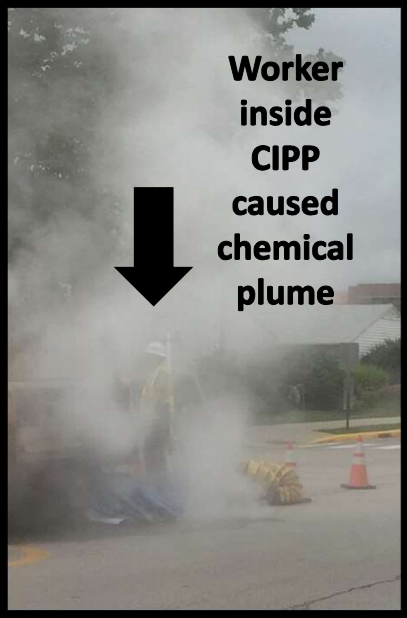
All condensates were representative of the same resin and steam cured CIPP.

Styrene was not the only compound that contributed to chemical toxicity

Lisa M. Kobos, Jonathan H. Shannahan; 2017

Observations

1. Independent air testing data is extremely limited
2. Chemical air emissions can be high and transient
3. The white chemical plume was a multi-phase mixture: Organic vapor, water vapor, particulate (condensable vapor, partially cured resin), and liquid droplets (water, organics)
4. Many VOCs, some SVOCs emitted
5. Some condensates caused toxicity to mouse lung cells
6. Styrene was not the only compound contributed to chemical toxicity.



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Thank You

If you are interested in partnering with us, please contact us.

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