

Repairing Infrastructure: Potential Implications to Public Health

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Standing Committee on Medical and Public
Health Research During Large-Scale
Emergency Events

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A Large-Scale Emergency Event: 2014 Chemical Spill in West Va

Federally declared disaster – Bounded rationality

Lesson:

**Need to anticipate public health challenges to
head-off a large-scale disaster**



Residential tap water sampling and survey for the Freedom Ind. chemical spill; Whelton et al. (2014) *ES&T*
The crude MCHM spill in Charleston, West Va; Rosen et al. (2014) *Journ. AWWA*
Decontaminating chemically contaminated plumbing; Casteloos et al. (2016) *ES: WR&T*
Surfactant use for plumbing decon; Casteloos et al. (2016) *Journ. HAZMAT*
Chemical volatilization during plumbing flushing and contaminated water use; Omur-Ozbek et al. (2015) *Proc.*
Acute toxicity differences between crude MCHM and pure MCHM on *Daphnia magna*; Novy et al. (2014). *Thesis.*
Chemical Spills Lessons Learned; Weidhaas et al. (2016) *Journ. Environ. Qual.*
Sublethal toxicity of crude MCHM to *Daphnia magna*; ongoing with USGS (awaiting their data since 2015)
Developmental impacts on *Danio rerio* cause by Crude MCHM; ongoing
Case Study: West Va. chemical spill; ongoing



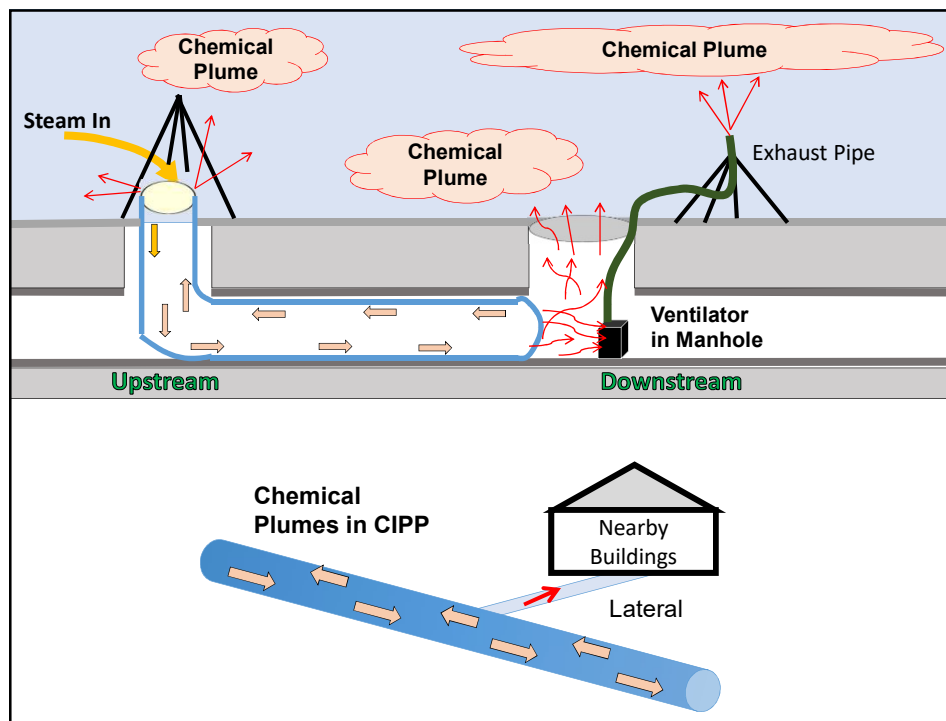
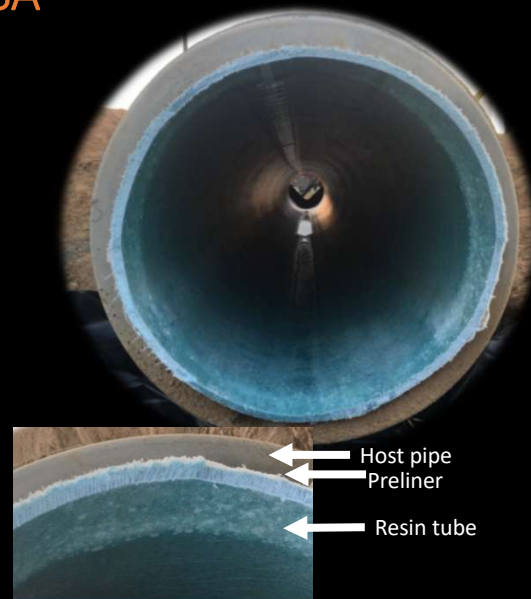
Today, Cured-in-Place-Pipe (CIPP) is used to repair 50% of all water pipes in the USA

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



Discharge into residential areas

Incident Location	Styrene	Description of Events from Reference
West Lafayette, IN (Whelton 2016)	nr	Fumes entered campus building through floor drains; doors opened to ventilate; no fired apartment called; contractor said just odor, 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 2 nd 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

CIPP Contractors and Water Utilities Across the US Acknowledge that Workers and the General Public Are Exposed to CIPP Chemicals

"...is not a human health risk." – 2016, Metropolitan Water Reclamation District of Greater Chicago, IL

"...styrene vapor of at most a few ppm...." - 2016, Hagerstown, MD

"...do not be alarmed." - 2016, Evanston, IL

"...it is at levels significantly lower than the allowable exposure limits" - 2016, Northeast Ohio Regional Sewer District, OH

"...May notice 'chemical-like' odor. Safe for people and animals." – 2016, Kansas City, MO





"...styrene levels are below permissible exposure limits and will not pose any hazardous conditions" – 2015, Orange County Sanitation District, CA

"Some people are offended by this odor and are fearful of it; even though the concentrations they smell present no harm" – 2016, Winooski, VT

"The amount of airborne styrene the repair process produces is not a human health risk" – 2015, City of Portland, OR

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Current Assumptions by Industry: Styrene is the Only Organic Chemical Emitted from CIPP, Few ppm is the Highest Level

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)

Buildings tested 7 (2000), 2 (2001)
Sewer pipe layout unclear

Manholes (Single 2-8 hr samples)
0.16 to 1.5 ppm with preliner
3.2 ppm maximum without preliner

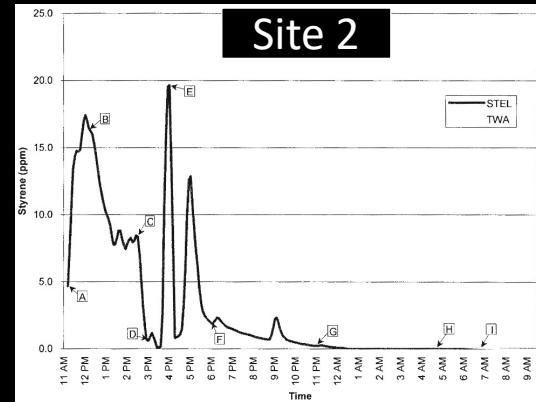
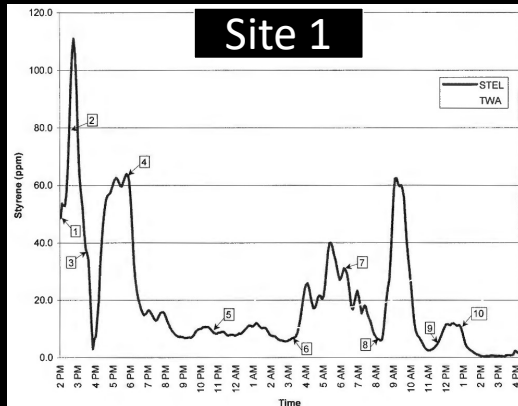
Breathing zone (Single 4-9 hr samples)
0.08 to 0.5 ppm, workers

Indoors (Single ~24 hr samples)
0.1 to 0.2 ppm, worst-case during the CIPP process
Highest concentrations, dry plumbing traps

"...it does not appear that it is a significant source of any other VOCs...."

In 2004, CIPP PID Air Testing Study was conducted in Canada

Bauer & McCartney, 2004. Proc. No-Dig.



Observations:

*PID set for styrene, but real-time measured STEL?
One air sample collected every 15 minutes (4/hr), but solid lines used
Did not start monitoring until after CIPP installed*

In 2005, ATSDR Found CIPP Styrene and Other VOCs Entered Office Building through the Foundation, Chemicals Lingered for Months

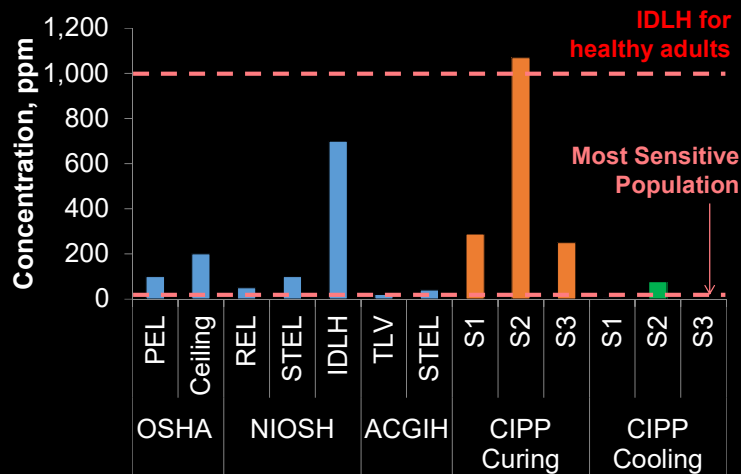
Date	Total VOC, ppm	Styrene, ppm
12/10	Evacuation	Evacuation
12/13	Evacuation	Evacuation
12/13-22	nd – 1.45	Not tested
12/22	nd – 199.0	Not tested
1/12	0.5 – 30.0 ⁺	Not tested
1/13	nd – 1.77	nd – 0.30
1/18	nd – 1.60	Not tested
1/21	nd – 0.86	nd – 0.22
2/4	nd – 0.21	nd – 0.15
2/7	nd – 0.57	nd – 0.04
3/28	nd – 0.22	nd – 0.01



"...past conditions at the site are classified as a public health hazard."

Styrene odor threshold < 0.1 ppm

2015, Styrene Exiting Manhole in Los Angeles Exceeded the NIOSH IDLH



Elena Adjari, Ph.D. (2016)

Limitations with Existing CIPP Air Testing Studies are Significant

- Very limited air monitoring data available
- Air flow in sewers near buildings unclear
- Monitoring conducted far from generation sites
- Very few CIPP contractors and resin systems monitored
- No characterization of resin or CIPP, What could be released?
- Air monitoring began after installation, hours to days to months
- Nonstyrene contaminants may have sorbed to sampling materials
- Multi-hour sample misses more transient, higher concentration exposures

And more...



2015 Los Angeles, CA

2016 NSF RAPID Response Study

Goal

To better understand chemical emission from CIPP installations

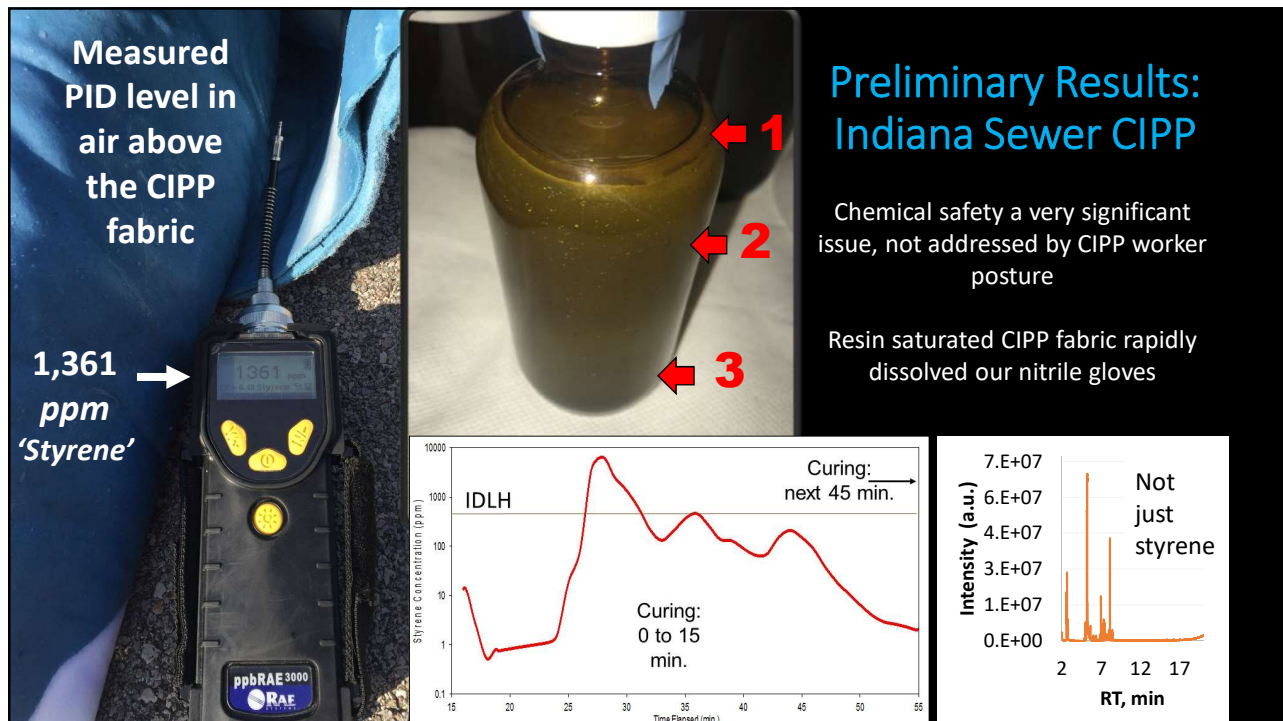
Objectives

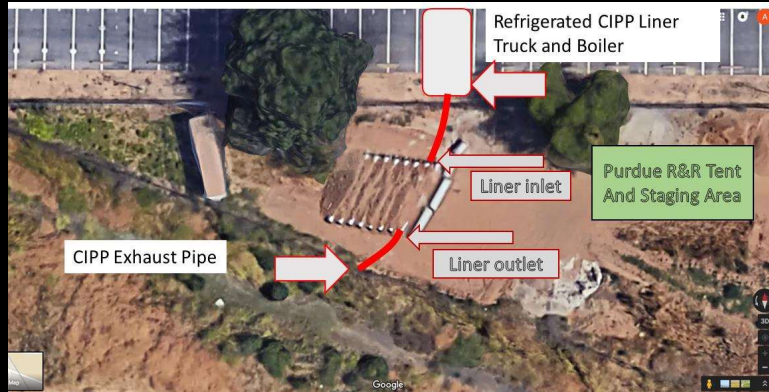
- 1) Compare different air sampling strategies
- 2) Evaluate chemical air emissions under different installation conditions
- 3) Identify chemicals emitted and their magnitudes



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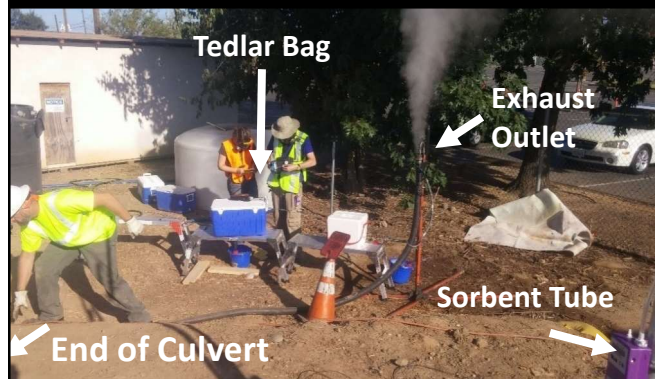
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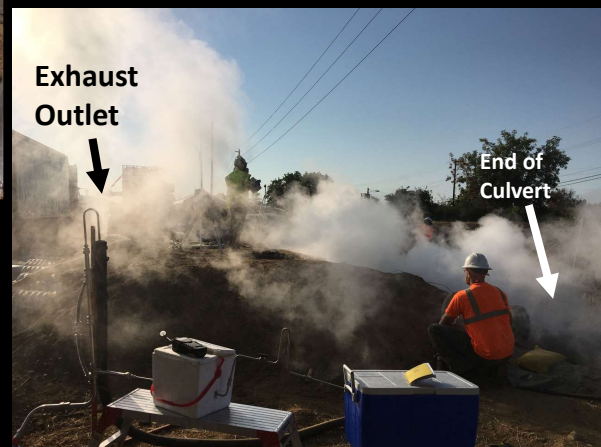


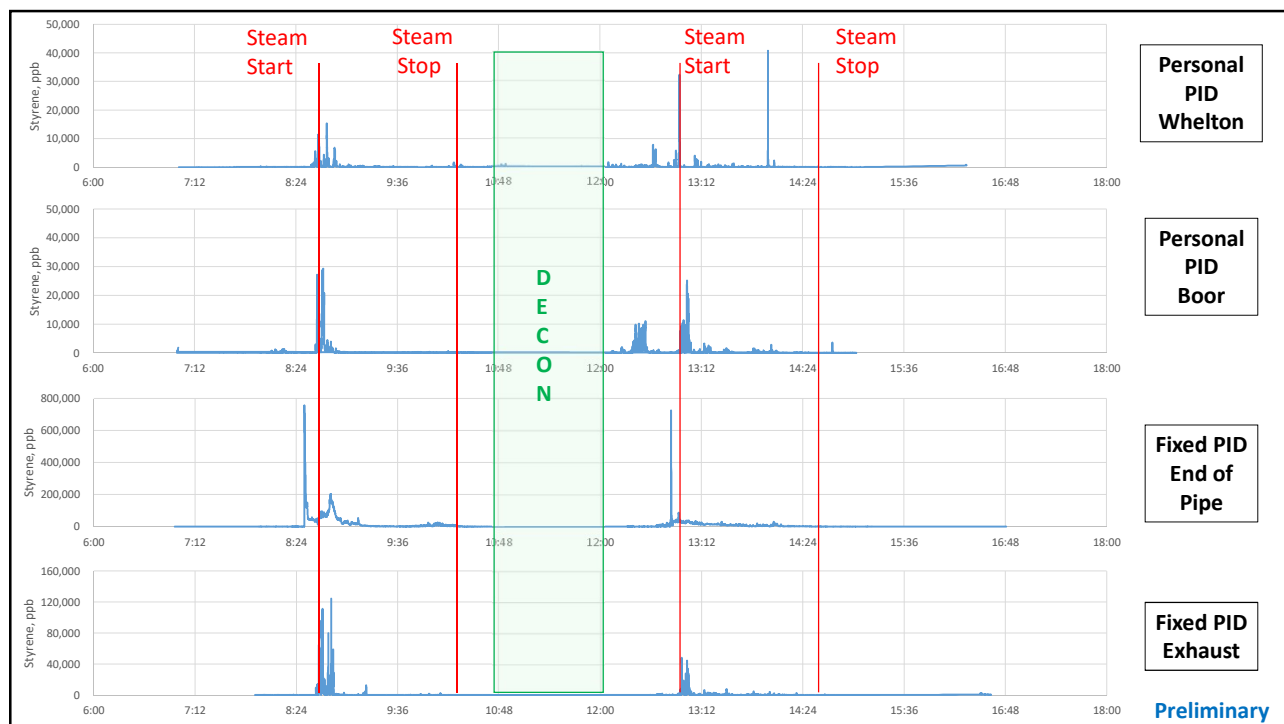
Preliminary Results: California CIPP

Site	Host Pipe	Pulled Separate Preliner	Resin Type	Cooldown Method	Insertion Method
1	CSP	Yes, 1	A	Ambient air	Air inversion
2	CSP	No, 0	B	None	Air inversion
3	CSP	Yes, 2	A	Hot air	Air inversion
4	RCP	Yes, 1	A	None	Air inversion
5	CSP	No	A	None	Pull-in



Preliminary Results: California CIPP





If PIDs Only Detected Styrene Being Emitted in California

Organization & their Styrene Exposure Limit	Standard	Conditions	Value	Was Limit Exceeded at CIPP Site? (Site #)				
				1	2	3	4	5
OSHA PEL – Gen. Industry	TWA	8 hr	100 ppm	Y	Y	N	N	Y
	Ceiling	Never to exceed	200 ppm	Y	N	N	N	Y
	“Exception to ceiling”	Max. peak duration is for 5 min in any 3 hr	600 ppm	Y	Y	N	N	Y
Cal OSHA	TWA	8 hr	50 ppm	Y	Y	N	N	Y
	STEL	15 min average	100 ppm	Y	Y	Y	N	Y
	Ceiling	Never to exceed	500 ppm	Y	N	N	N	Y
NIOSH REL	TWA	Up to 10 hr	50 ppm	Y	Y	N	N	Y
	STEL	15 min average	100 ppm	Y	Y	Y	N	Y
	Ceiling	Never to exceed	500 ppm	Y	N	N	N	Y
NIOSH	IDLH	Exposure is likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from such an environment	700 ppm	Y	N	N	N	Y
ACGIH TLV	TWA	8 hr	20 ppm	Y	Y	Y	Y	Y
	STEL	15 min average or other	40 ppm	Y	Y	Y	Y	Y
City of Toronto, CN	General public	1 hr, Exposure limit set by Local Health Dept.	5 ppm	Y	Y	Y	Y	Y
TCEQ, acute reference value	General public	1 hr, Set by TX Comm. Env. Quality	5 ppm	Y	Y	Y	Y	Y

Preliminary Results: California CIPP

We are still analyzing and interpreting data.

Current Preliminary Observations

- Serious health and environmental threats may exist – For years workers and public have been told none exist, prior CIPP air testing data not adequate, other *in-situ* pipe repair technologies not addressed
- Emissions are highly transient, high temperature, high flowrate
- Chemical plume contained multi-phase materials
- These few sites are not enough to understand variation across the U.S.

Who's at Risk?

Thousands of CIPP workers and millions of people near emissions

Relevance to Large-Scale Emergencies and Public Health

Incorrect assumptions about personal safety, more data needed

Uncertainty abounds - Formulations, contractor procedures

Odor detection means person is being exposed, not that the exposure is safe

Lack of odor means we do not know if people are being exposed

Public health officials, CIPP workers, HAZMAT, public lack the necessary data

Preliminary Next Steps

Complete data analysis

Worker and public education

Investigation of hazards to those exposed

Test many more sites

Screen tentatively identified compounds (TIC)

Conduct risk assessments

*Need to anticipate
public health
challenges to head-
off a large-scale
disaster*

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CIPP air toxics RAPID response:

<https://crowdfunding.purdue.edu/project/2768>

