CURED-IN-PLACE-PIPE [CIPP]

Cured-in-place-pipe (CIPP) installation is a relatively new method used for sewer line and culvert rehabilitation. Recently, concerns were raised regarding the possibility of residual chemical releases during the installation process and related harm to human health.

This factsheet will help you to learn more about the CIPP process — what it is, how it may harm your health and how to protect yourself and your family from possible health effects.

General Facts

What is CIPP?

Cured-in-place-pipes (CIPP) are jointless, seamless, flexible plastic pipe liners chemically installed within an existing sewer, water, gas or other pipe.

CIPP is used during the repair process of defective sewer lines, culvert and drinking water pipes. The process involves the insertion of an uncured tube of resin into the existing, defective pipe. Hot air and/or water or ultraviolet light are used, expanding and hardening (curing) the tube creating a liner to fit against the wall of the “broken” pipe.

The purpose of the curing process is to reduce, and ideally eliminate, cracks and holes that would otherwise allow rainwater and roots to enter the sewer pipe and cause operational problems such as stoppages and overflows. The new liner can also help prevent mechanical failure.

Why is CIPP used?

CIPP is used to repair pipes without disturbance to surface structures or other utilities near broken pipes. It is advertised by some contractors to be a more efficient and cheaper process to repair pipes. Some, new CIPPs are designed to have an estimated 50-year lifespan.

What does CIPP consist of?

A new CIPP is created using a number of materials: a resin, a chemical initiator package, a reinforcement material and other additives. The most popular resins today include:

- Styrene-based polyester
- Styrene-based vinyl ester
- Vinyl ester (styrene free)
- Epoxy (styrene free)

Why is the CIPP process a concern?

Chemicals are released into the air during a CIPP project setup, while the CIPP is made and after the plastic liner has been created. The tube of uncured resin as well as its delivery and handling can release chemicals into the air. In addition, forced air, steam and hot water use also releases chemicals into the air and can potentially transfer the chemicals from the process into a worksite, nearby pipes, nearby residences through plumbing, open windows, doors, cracked foundations and in the environment causing

ambient and indoor air contamination incidents. These ambient and indoor air contamination incidents can possibly harm human health, and research is needed to understand the extent of the chemical release from CIPP installation processes.

Furthermore, there have been more than 100 incident reports nationwide. These reports involved chemical discharges from CIPP sites directly into waterways and sanitary sewer systems leading to excessive odors, fish kills, downstream (chemicals can travel several kilometers) drinking water contamination, violation of state water pollution laws and air contamination sometimes prompting illness.

The composition of the waste emitted into the air is poorly understood. Though, during a CIPP project where steam is injected, the waste discharges into air as gaseous, solid and/or liquid chemical mixture consisting of:

- Volatile[1] organic compounds (VOC)
- Semi-volatile[2] organic compounds (SVOC)
- Particulates
- Liquid droplets

Chemicals released into the environment and inside buildings through the CIPP installation process can sometimes be found more than one month after the actual installation.

The Agency for Toxic Substances and Disease Registry (ATSDR) determined that a CIPP installation at a site in Milwaukee, Wisconsin, caused an indoor air pollution 'public health hazard'. In 2019, the U.S. National Institute for Occupational Safety and Health (NIOSH) found styrene and divinylbenzene in air for a UV CIPP project, where styrene exceeded the NIOSH suggested limit at which harmful health effects may be expected for the workers.

What specific compounds have been identified in the gaseous, solid and/or liquid chemical mixture?

Chemical identification and air concentration data from CIPP manufacturing sites are lacking and available results are likely not fully representative of worksites. In the past, styrene has often been the only contaminant looked for and has been found above health screening values. Some of the volatile[1] and semi-volatile[2] compounds recently confirmed in the air during the CIPP installation are:

- Acetone
- Acetophenone
- Benzaldehyde
- Benzene
- Benzoic acid
- Butylated hydroxytoluene (BHT)
- 4-*tert*-Butylcyclohexanol
- Carbon disulfide
- Carbon tetrachloride
- Chloroform
- Cyclohexane
- Dibutyl phthalate (DBP)
- 1,4-Dioxane
- 1,4-Ethanol
- Ethyl acetate (Vinyl acetate)
- Ethylbenzene
- Hexane
- Isopropanol
- 2-Methylbutane
- Methylene chloride
- Methyl ethyl ketone (MEK)
- Phenol
- Styrene
- 1-Tetradecanol
- Toluene
- 1,2,4-Trimethylbenzene
- 1,3,5-Trimethylbenzene
- m,p-Xylene
- o-Xylene

For detailed information regarding chemical maximum reporting concentrations and public exposure limits, see Attachment 1. More chemicals have been identified in the CIPP resins and others are created and released onsite during the plastic CIPP liner manufacture.

[1] Volatile: Easily evaporated at normal temperature.
[2] Semi-Volatile: Evaporate at a higher temperature.

How can exposure to the gaseous, solid and/or liquid chemical mixture potentially affect health?

The health effects of any chemical exposure vary based on chemical concentration, emission composition, exposure duration, individual breathing rate and the susceptibility of the individual to chemical exposure.

Community members near CIPP installation sites have reported odors and illness symptoms such as:

- □ Nausea
- □ Headache
- □ Vomiting
- □ Breathing difficulties
- □ Eye irritation
- □ Nasal irritation

Some other symptoms when exposed to the chemicals mentioned above could be:

- □ Changes in color vision
- □ Slowed reaction time
- □ Feeling drunk
- □ Balance problem
- □ Hearing loss
- □ Concentration problems
- □ Tiredness

Can exposure to the gaseous, solid and/or liquid chemical mixture cause cancer?

The U.S. Environmental Protection Agency (EPA) listed acetone, acetophenone, benzoic acid, dibutyl phthalate, phenol and *m*-,*p*-Xylene / *o*-Xylene in Group D: *Not classifiable as to human carcinogenicity*. The International Agency for Research on Cancer (IARC) has listed toluene as possibly not carcinogenic to humans (Group 3).

EPA classified benzene, carbon tetrachloride, chloroform, 1,4-dioxane and methylene chloride as either carcinogenic, likely or probable carcinogenic. In addition, IARC has determined that carbon tetrachloride and ethylbenzene are possible carcinogens (Group 2B) and styrene is probably a carcinogen (group 2A). Evidence for cancer from styrene exposure in humans is from occupational (workplace) studies showing increased risks for workers developing:

- ❖ Lymphohematopoietic cancers (such as leukemia and lymphoma)
- ❖ Genetic damage in the white blood cells, or lymphocytes

Some animal studies have suggested a higher risk of lung tumors when exposed to styrene as well as lung and liver tumors when inhaling another component of CIPP, methylene chloride.

Some increased cancer risk with inconsistent evidence was reported in the:

- □ Pancreas
- □ Breast
- □ Liver
- □ Prostate
- □ Rectum
- □ Brain

Currently, there are not enough data / studies available to evaluate the carcinogenicity of benzaldehyde, butylated hydroxytoluene, carbon disulfide, cyclohexane, hexane, isopropanol, 1-tetradecanol as well as 1,2,4-trimethylbenzene and 1,3,5-trimethylbenzene (TMBs).

How can I protect myself and my family when I live and/or work nearby a CIPP installation site?

There is a limited amount of information available about the potential human health risks to workers and the public when exposed to the gaseous, solid and/or liquid chemical mixture. NIOSH recommends that workers ventilate the CIPP rehabilitation site and bag excess liner immediately. Until more information is gathered, it is recommended for workers to use the appropriate personal protective equipment (PPE) such as respirators and chemical-resistant gloves. It is suggested to change gloves regularly when in contact with the liner. Members of the public can protect themselves by minimizing exposure through the air (breathing) and on the skin. If an unidentified odor and health symptoms are experienced near a CIPP

installation site, it is suggested to leave the area of concern, seek medical assistance if needed and report odors and symptoms to your local health department.

CIPP Regulation and Advisories

Currently, no regulations for the CIPP process specific to environmental and public health protection are known. The Occupational Safety and Health Administration (OSHA) and NIOSH have set general exposure limits for some of the chemicals mentioned above for healthy adult workers in a worker environment. The California EPA Office of Environmental Health Hazard Assessment has set some acute and chronic reference exposure levels for styrene (4.9 ppm_v[3] and 0.2 ppm_v, respectively) for residential and building occupants considering sensitive subpopulations including infants and children.

Segments of new CIPPs are collected and tested often for strength as a condition of installation. The American Society for Testing and Materials (ASTM) provides some recommendations for examining new CIPPs. Though, ASTM recommendations are not enforceable.

The CIPP process generates waste discharged into the air and water based on current practice and past incidences. The Clean Water Act and Clean Air Act were both enacted and established to regulate pollution in water and air to protect the environment. The Clean Water Act established guidelines for regulating the discharge of pollutants into water and the regulation of water quality standards. The Clean Air Act regulates the release of air pollutants from both stationary and mobile sources.

Biomonitoring and Blood Testing

Can a test determine whether I have been exposed to the gaseous, solid and/or liquid chemical mixture released during the CIPP process?

Most chemicals named above can be measured in blood, urine, serum and body tissues. Specifically, styrene can be measured for a short time following exposure to moderate-to-high levels. This should be done within a few hours after exposure occurs because these metabolites leave the body very quickly.

When is testing for the gaseous, solid and/or liquid chemical mixture released during the CIPP installation useful? What do the results tell me?

According to ATSDR, the presence of chemicals in general can be measured in blood, urine and serum. However, the results generally are not useful when the specific exposure time, duration and location are unknown. Further, some chemicals are present in blood, serum and urine naturally. For example, low levels of acetone are normally present in the body from the breakdown of fat. The body uses acetone in normal processes that make sugar and fats producing energy for normal body functions. Phenol is expected to be present in blood and urine in its unharmful forms.

For other chemicals that are not in your blood naturally, such as styrene, a urine test can measure the breakdown products (metabolites) and might indicate that you were exposed to styrene; however, these metabolites can also form when you are exposed to other substances.

[3] ppm_v – parts per million by volume (typically used for gaseous mixtures)

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If you have questions or comments about this factsheet, we encourage you to contact us.

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ATTACHMENT 1:

Table 1: Chemical identification and air concentration data from CIPP manufacturing

Chemical Compounds	Maximum Concentration Reported [ppm]	Public Exposure Limits	Chemical Compounds	Maximum Concentration Reported [ppm]	Public Exposure Limits
Acetone	2.6486*	200 (10 min; AEGL-1)†	**Ethylbenzene**	0.2674*	33 (10 min; AEGL-1)†
Acetophenone	Not mentioned‡	Not available	**Hexane**	0.3255*	4,000 (10 min; AEGL-1)†
Benzaldehyde	0.3183* Not mentioned‡	Not available	**Isopropanol**	0.0248*	Not available (only for workers)
Benzene	0.0352*	0.41 (6 hrs)§	**2-methylbutane**	0.0251*	Not available (only for workers)
Benzoic acid	Not mentioned‡	Not available	**Methylene chloride**	0.0169*, >1.56**	4.03 (1 hr)§
Butylated hydroxytoluene (BHT)	Not mentioned‡	Not available (only for workers)	**Methyl ethyl ketone (MEK)**	0.0256*	200 (10 min; AEGL-1)†
4-*tert*-Butylcyclohexanol	Not mentioned‡	Not available	**Naphthalene**	0.0029*	Not available (only for workers)
Carbon disulfide	0.0246*	1.99 (6 hrs)§	**Phenol**	Not mentioned‡	0.4 (6 hrs)§
Carbon tetrachloride	0.0000037*	0.3 (7 hrs)§	**Styrene**	Varies from 3.2†† to 1,824*, Not mentioned‡	4.93 (1 hr)§
Chloroform	0.0000133*	0.03069 (7 hrs)§	**1-Tetradecanol**	Not mentioned‡	Not available
Cyclohexane	0.3759*	Not available (only for workers)	**Toluene**	0.7091*	9.82 (1 hr)§

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Table 1 (continued): Chemical identification and air concentration data from CIPP manufacturing

Chemical Compounds	Maximum Concentration Reported [ppm]	Public Exposure Limits	Chemical Compounds	Maximum Concentration Reported [ppm]	Public Exposure Limits
Dibutyl phthalate (DBP)	Not mentioned‡	Not available (only for workers)	**1,2,4-Trimethylbenzene**	0.0572*	0.18 (10 min; AEGL-1)§
1,4-Dioxane	0.00998*	0.83 (1 hr)§	**1,3,5-Trimethylbenzene**	0.0108*	180 (10 min; AEGL-1)†
Ethanol	1.4403*	1,000	**m,p-Xylene**	0.0365*	5.06 (1 hr)§
Ethyl acetate (Vinyl acetate)	0.0067*	Not available (only for workers)	**o-Xylene**	0.0088*	5.06 (1 hr)§

AEGL = Acute Exposure Guideline Levels
hr(s) = hour(s)
min = minute
ppm = parts per million