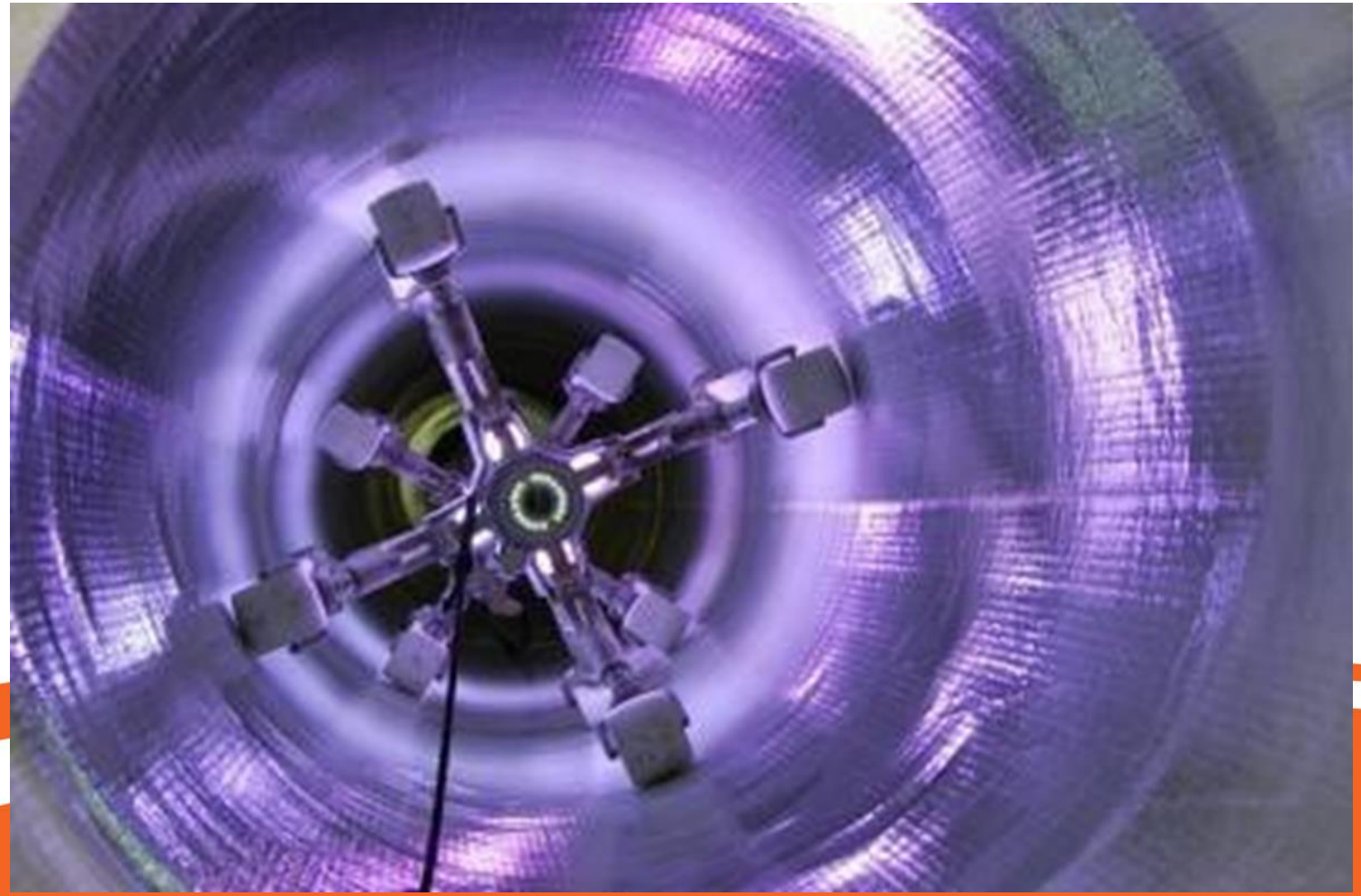
WTA

Brian Glaeser – Presenter
Subsurface Inc.

Trenchless Pipe Rehabilitation using High Strength UV Cured GRP Liners

Pipe Failures have Catastrophic Results

What are UV Cured CIPP Liners?



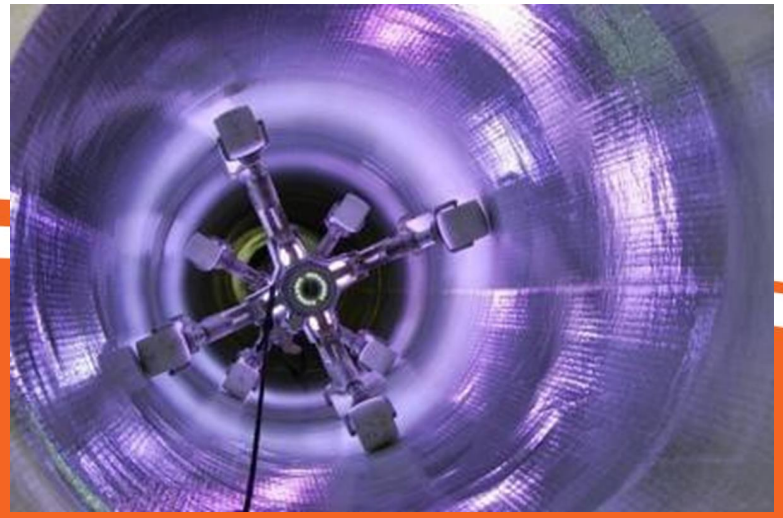
UV Cured-In-Place-Pipe (CIPP)

- UV CIPP is a trenchless rehabilitation method used to repair existing pipelines.
- UV CIPP is a joint-less, seamless, pipe-within-a-pipe.
- It has the capability to rehabilitate pipes ranging in diameter from 6”-72”).
- Each UV CIPP Liner must meet specific criteria designed specifically for each pipe.
- Starts out as raw fiberglass and resin and is made into a tube that will be pulled into place, inflated and cured in place.
- Made to the thickness and diameter required by ASTM standards.

- Developed in Germany in 1990.
- Technology was introduced into the US 2008.
- Only manufacture can produce and distribute to installers.
- Diameters 6” – 72”.
- Maximum length up to 1800LF depending on diameter and thickness.
- Maximum wall thickness 15.6mm.

Steam Cured Felt Liners vs. UV Cured Liners

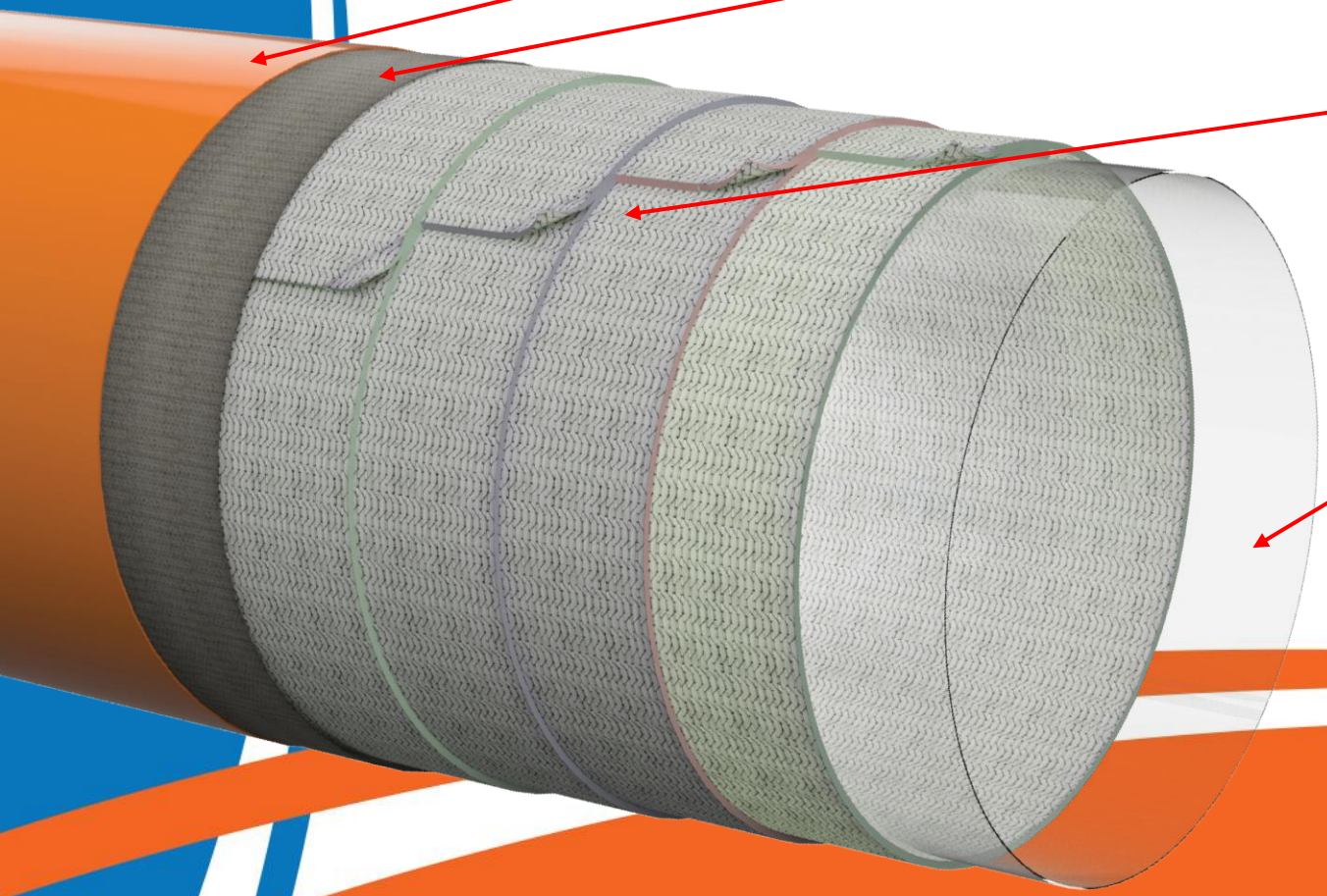
- **Felt Liner:** Must be refrigerated to prevent premature curing with a shelf life of approx. 30 days if wet-out liner has been kept at the proper temperature.
- **UV Liner:** No Refrigeration and 6 month shelf life.
- **Felt Liner:** Must be Inserted into pipe and pressurize to obtain snug fit with host pipe. Temperatures unknow except at very beginning and very end.
- **UV Liner:** Temperatures/pressures known through entire process
- **Felt Liner:** Cured by blowing steam into liner
- **UV Liner:** Cured by UV Light
- **Felt Liner:** Styrene Infused Condensate must be contained and, inside of liner should be washed and contaminated water hauled to a registered containment center.
- **UV Liner:** Liner resin is fully encapsulated leaving no contaminants in soils or area waters. No discharge of styrene laden water
- **Felt Liner:** Uncured liner must be disposed of in a hazardous waste disposal site and documented.
- **UV Liner:** Can be disposed of normally.



Why Consider UV CIPP over Slip lining?

What Exactly is an Ultra-Violet Cured-In-Place Pipe Liner made of?

UV GRP Liner Manufacturing
Multi Layered Construction



Outer Foil
- Additional layer of protection.
- Creates a barrier between hot pipe and liner.
- UV light impermeable.

Fleece
- Restricts excess movement of the resin.

E-CR Fiberglass
- Electrical grade, Corrosion resistant.
- Reinforcing strength and structure.

Resin
- UV light activated.
- Strength hardening agent.

Inner Foil
- Barrier on the inside to contain fiberglass and resin.
- Inflation foil.

Wall thickness governed by ASTM F1216- Design Calculation

UV GRP Liner Manufacturing

- Each liner is custom designed based on the host pipe environment.
- To determine thickness, pipe specifications are provided to determine minimal thickness:
  - Depth of cover over the pipe
  - Water Table
  - Live Load over the pipe
  - Pipe Ovality
  - Soil Modulus

UV GRP Liner Impregnation

Quality

- Every step of the liner impregnation is monitored for quality control purposes.

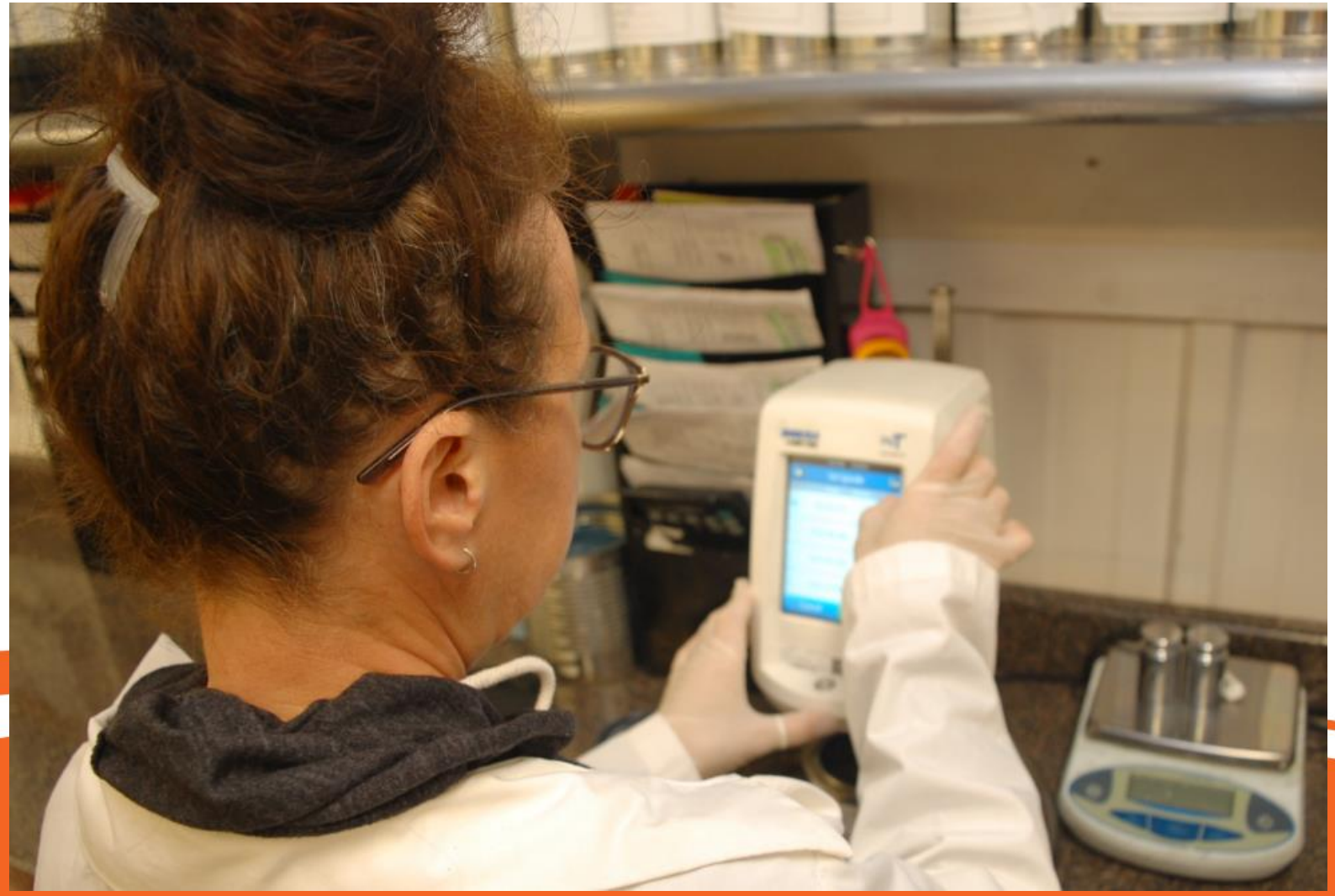
Injection

- Resin is injected into the fiberglass layers and pinch rollers are used to disperse the resin evenly throughout the fiberglass mat.

UV GRP Liner Packaging

Durable, custom-built crates for each liner

On-Site Resin Testing



Flexural & Tensile Testing

Quality Control and Testing

- ASTM F1216 Chemical Test
- ASTM D2990 10,000hr Test
- ASTM D 790
- ASTM F 2019
- ASTM D 2122
- ASTM D 3567
- ASTM D 2990
- ASTM D 543
- ASTM D 638
- ASTM D 695
- ASTM D3039

ISO 9001:2015 Certified

Conforms to ASTM F2019-22

Designation: F2019 – 22

Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Pulled in Place Installation of Glass Reinforced Plastic Cured-in-Place (GRP-CIPP) Using the UV-Light Curing Method[1]

This standard is issued under the fixed designation F2019; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This practice covers the procedures for the reconstruction of pipelines and conduits (4 in. to 72 in. (100 mm to 1830 mm) diameter) by the pulled-in place installation of a resin-impregnated, glass fiber tube into an existing pipe or conduit followed by its inflation with compressed air pressure (see Fig. 1) to expand it firmly against the wall surface of the host structure. The photo-initiated resin system in the tube is then cured by exposure to ultraviolet (UV) light. When cured, the finished cured-in-place pipe will be a continuous and tight fitting pipe within a pipe. This type of reconstruction process can be used in a variety of gravity flow applications such as sanitary sewers, storm sewers, process piping, electrical conduits, and ventilation systems.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C1920 Practice for Cleaning of Vitrified Clay Sanitary Sewer Pipelines

D543 Practices for Evaluating the Resistance of Plastics to Chemical Reagents

D578 Specification for Glass Fiber Strands

D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

D1600 Terminology for Abbreviated Terms Relating to Plastics

D2990 Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics

D3567 Practice for Determining Dimensions of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe and Fittings

D5813 Specification for Cured-In-Place Thermosetting Resin Sewer Piping Systems

F412 Terminology Relating to Plastic Piping Systems

F1216 Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube

F1417 Practice for Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-Pressure Air

2.2 *ISO Standards:*[3]

11296-4 Plastics piping systems for renovation of underground non-pressure drainage and sewerage networks – Part 4: Lining with cured-in-place pipes

[1] This practice is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.67 on Trenchless Plastic Pipeline Technology.

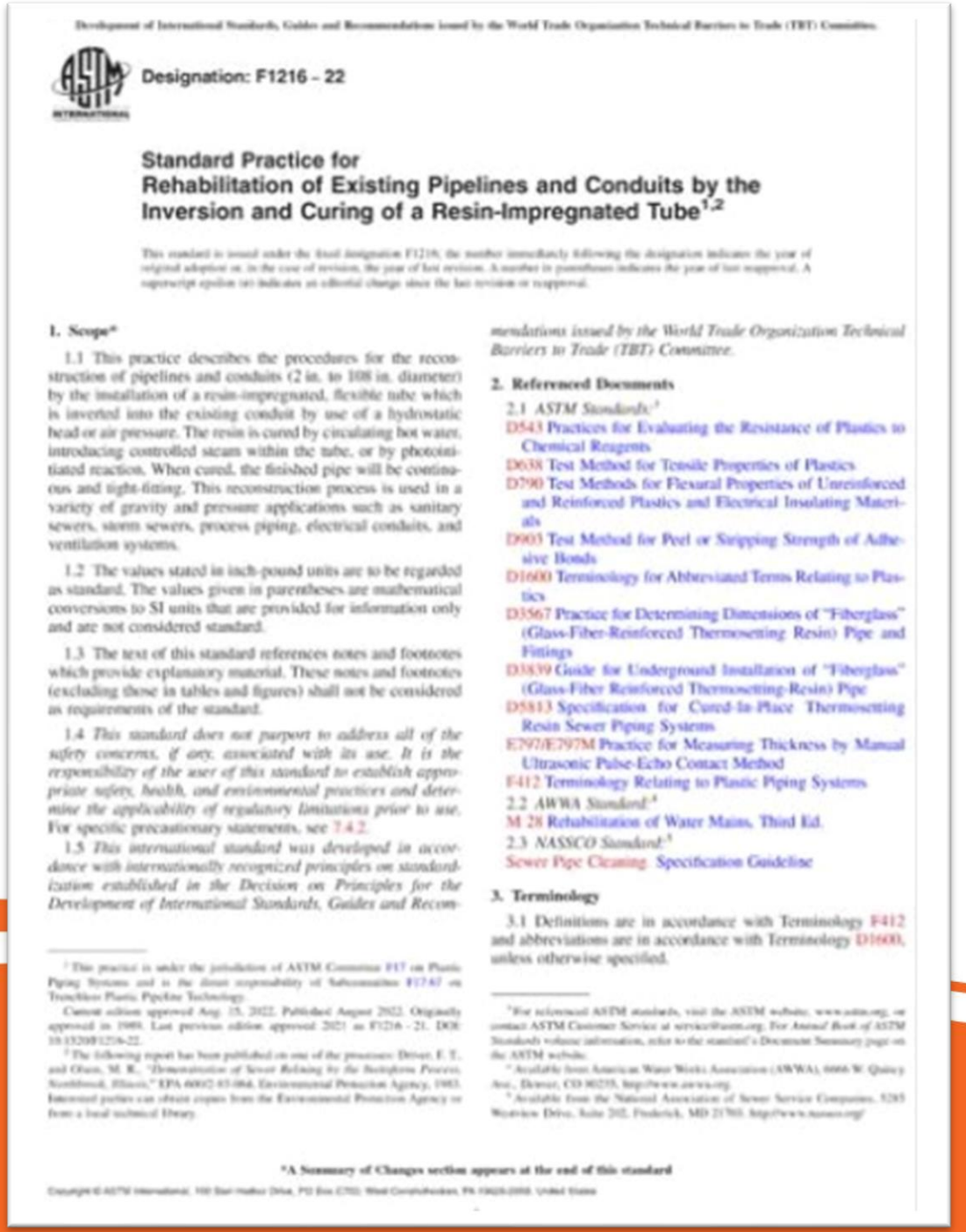
Current edition approved Nov. 15, 2022. Published December 2022. Originally approved in 2000. Last previous edition approved in 2020 as F2019 – 20. DOI: 10.1520/F2019-22.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, http://www.iso.org.

*A Summary of Changes section appears at the end of this standard

Conforms to ASTM F1216-22



Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

Designation: F1216 – 22

Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube[1,2]

This standard is issued under the fixed designation F1216; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This practice describes the procedures for the reconstruction of pipelines and conduits (2 in. to 108 in. diameter) by the installation of a resin-impregnated, flexible tube which is inverted into the existing conduit by use of a hydrostatic head or air pressure. The resin is cured by circulating hot water, introducing controlled steam within the tube, or by photoinitiated reaction. When cured, the finished pipe will be continuous and tight-fitting. This reconstruction process is used in a variety of gravity and pressure applications such as sanitary sewers, storm sewers, process piping, electrical conduits, and ventilation systems.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 The text of this standard references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary statements, see 7.4.2.

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]
D543 Practices for Evaluating the Resistance of Plastics to Chemical Reagents
D638 Test Method for Tensile Properties of Plastics
D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
D903 Test Method for Peel or Stripping Strength of Adhesive Bonds
D1600 Terminology for Abbreviated Terms Relating to Plastics
D3567 Practice for Determining Dimensions of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe and Fittings
D3839 Guide for Underground Installation of "Fiberglass" (Glass-Fiber Reinforced Thermosetting-Resin) Pipe
D5813 Specification for Cured-In-Place Thermosetting Resin Sewer Piping Systems
E797/E797M Practice for Measuring Thickness by Manual Ultrasonic Pulse-Echo Contact Method
F412 Terminology Relating to Plastic Piping Systems
2.2 *AWWA Standard:*[4]
M 28 Rehabilitation of Water Mains, Third Ed.
2.3 *NASSCO Standard:*[5]
Sewer Pipe Cleaning Specification Guideline

3. Terminology

3.1 Definitions are in accordance with Terminology F412 and abbreviations are in accordance with Terminology D1600, unless otherwise specified.

[1] This practice is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.67 on Trenchless Plastic Pipeline Technology.

Current edition approved Aug. 15, 2022. Published August 2022. Originally approved in 1989. Last previous edition approved 2021 as F1216 – 21. DOI: 10.1520/F1216-22.

[2] The following report has been published on one of the processes: Driver, E. T., and Olsen, M. R., "*Demonstration of Sewer Relining by the Swissliner Process, Northbrook, Illinois*," EPA 600/2-83-084, Environmental Protection Agency, 1983. Interested parties can obtain copies from the Environmental Protection Agency or from a local technical library.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[4] Available from American Water Works Association (AWWA), 6666 W. Quincy Ave., Denver, CO 80235, http://www.awwa.org.

[5] Available from the National Association of Sewer Service Companies, 5285 Westview Drive, Suite 202, Frederick, MD 21703, http://www.nassco.org/

*A Summary of Changes section appears at the end of this standard

Conforms to ASTM D5813-04

of the host or mold pipe used for sampling, when measured in accordance with 8.1.1.

6.3.2 *Lengths*—Types I, II, and III CIPP shall be designed to extend the full length of the existing pipe between the access points after installation and curing, unless otherwise required. The cured CIPP may be cut to project beyond the ends of the existing pipe as required by the owner.

6.3.3 *Wall Thickness*—The average wall thickness of Types I, II, and III CIPP shall not be less than the specified thickness. The minimum wall thickness at any point shall not be less than 87.5 % of the specified thickness when measured in accordance with 8.1.2.

6.4 *Chemical Resistance Requirements:*

6.4.1 Specimens of each grade for use in sewer applications shall be evaluated in a laminate form by qualification test in accordance with 8.2.1. The specimens shall be capable of exposure to the solutions in Table 1 at a temperature of 73.4 ± 3.6°F (23 ± 2°C) with a percentage retention of flexural modulus of elasticity, when tested in accordance with 8.3, of at least 80 % after one-year exposure. Flexural properties after exposure to the chemical solution shall be based on the dimensions of the specimen after exposure.

6.4.2 Specimens of each grade used in sanitary sewers shall be evaluated by qualification test in accordance with 8.2.2 at a temperature of 73.4 ± 3.6°F (23 ± 2°C). The specimens shall be capable of being deflected to meet the strain requirements of 8.2.2 without failure when exposed to 1.0 *N* sulfuric acid solution.

6.4.3 For more specific service environments, such as industrial applications, CIPP specimens shall be tested in accordance with 8.2.1, and a suitable resin may be selected by agreement between the manufacturer and the purchaser.

6.5 *Physical Properties*—Types I, II, and III field-cured CIPP specimens when tested for quality assurance in accordance with 8.3 shall have minimum flexural modulus of elasticity of 250 000 psi (1724 MPa), minimum flexural strength of 4500 psi (31 MPa), and a minimum tensile strength of 2500 psi (17 MPa), or as specified, whichever is greater.

7. Sampling

7.1 *Production Tests*—The CIPP sample shall be tested as to the conformance of the material to the workmanship, dimensional, and flexural requirements of 6.1, 6.2, and 6.4.

TABLE 1 Chemical Resistance Test Solutions

Chemical Solution	Grade 1	Grade 2 / Grade 3
Nitric acid, 1.0%	Yes	Yes
Sulfuric acid, 5.0%	Yes	Yes
ASTM Fuel C[A], 100%	Yes	Yes
Sodium Hydroxide, 0.5%	Not Recommended	Yes
Vegetable oil (cottonseed, corn, or mineral oil), 100%	Yes	Yes
Detergent[B], 0.1%	Yes	Yes
Soap[B], 0.1%	Yes	Yes

[A] In accordance with Specification D4814.
[B] In accordance with Test Method D543.

7.2 *Sampling Techniques:*

7.2.1 For each CIPP length designated by the purchaser, CIPP samples shall be prepared in accordance with 8.1.1 of Practice F1216.

7.2.2 In large-diameter applications and areas with limited access, CIPP samples shall be prepared in accordance with 8.1.2 of Practice F1216.

7.2.3 For CIPPs reinforced with oriented continuous or discontinuous fibers with a modulus $>3 \times 10^6$ psi (>20 GPa), CIPP samples shall be prepared in accordance with 8.1.2 of Practice F1216.

7.3 *Qualification Tests*—Sampling for qualification tests is not required unless otherwise agreed upon between the purchaser and the supplier. These tests include the chemical requirements test in 6.4. For qualification tests, a certification and test report for any given combination of fabric tube type, resin grade, and filler shall be furnished when requested by the purchaser.

8. Test Methods

8.1 *Dimensions:*

8.1.1 *Diameter*—Take outside diameter measurements in accordance with Practice D3567 of samples prepared in accordance with 7.2.

8.1.2 *Wall Thickness*—Take wall thickness measurements in accordance with Practice D3567 for samples prepared in accordance with 7.2. Make a minimum of eight measurements at evenly spaced intervals around the circumference of the sample to ensure that minimum and maximum thicknesses have been determined. Deduct from the measured values the thickness of any plastic coatings or CIPP layers not included in the structural design of the CIPP. Calculate the average thickness using all measured values.

8.2 *Chemical Tests:*

8.2.1 Test the CIPP in accordance with the testing procedures of Test Method D543. The edges of the test specimens shall be cut, left exposed, and not treated with resin.

8.2.2 In accordance with Test Method D3681, test four specimens each at the 10 and 10 000-h minimum strains, and test five specimens each at the 100 and 1000-h minimum strains given in Table 2. Consider the product qualified if all 18 specimens are tested without failure for at least the prescribed times given in Table 2 (that is 10, 100, 1000, and 10 000 h, respectively).

8.2.2.1 Apply force to each test specimen within the pipe apparatus with a properly calibrated compression testing machine of the constant cross-rate-of-crosshead movement type in

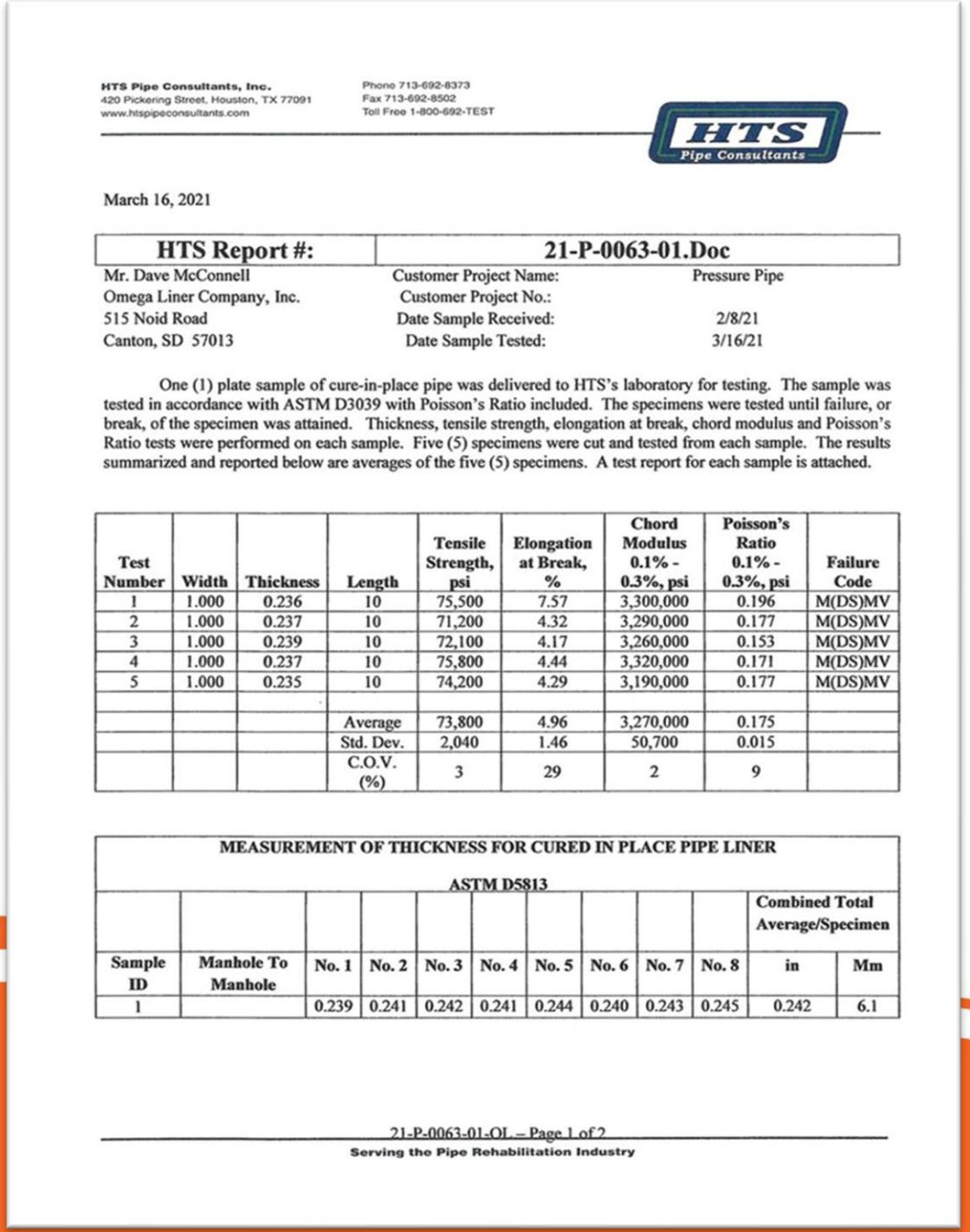
TABLE 2 Strain Corrosion Requirements

Time	Minimum Strain, %[A]
10 h	0.72
100 h	0.69
1000 h	0.67
10 000 h	0.64

[A] The strain levels listed in this table were selected to provide reasonable assurance that the minimum strength of CIPP materials will be 1.5 times a service strain level of 0.40 %.

Third Party Testing

- ASTM D3039
  - Thickness
  - Tensile
  - Strength
  - Elongation at Break
  - Average 73,800psi



HTS Pipe Consultants, Inc.
420 Pickering Street, Houston, TX 77091
www.htspipeconsultants.com

Phone 713-692-8373
Fax 713-692-8502
Toll Free 1-800-692-TEST

HTS Pipe Consultants

March 16, 2021

HTS Report #:	21-P-0063-01.Doc	
Mr. Dave McConnell	Customer Project Name:	Pressure Pipe
Omega Liner Company, Inc.	Customer Project No.:	
515 Noid Road	Date Sample Received:	2/8/21
Canton, SD 57013	Date Sample Tested:	3/16/21

One (1) plate sample of cure-in-place pipe was delivered to HTS's laboratory for testing. The sample was tested in accordance with ASTM D3039 with Poisson's Ratio included. The specimens were tested until failure, or break, of the specimen was attained. Thickness, tensile strength, elongation at break, chord modulus and Poisson's Ratio tests were performed on each sample. Five (5) specimens were cut and tested from each sample. The results summarized and reported below are averages of the five (5) specimens. A test report for each sample is attached.

Test Number	Width	Thickness	Length	Tensile Strength, psi	Elongation at Break, %	Chord Modulus 0.1% - 0.3%, psi	Poisson's Ratio 0.1% - 0.3%, psi	Failure Code
1	1.000	0.236	10	75,500	7.57	3,300,000	0.196	M(DS)MV
2	1.000	0.237	10	71,200	4.32	3,290,000	0.177	M(DS)MV
3	1.000	0.239	10	72,100	4.17	3,260,000	0.153	M(DS)MV
4	1.000	0.237	10	75,800	4.44	3,320,000	0.171	M(DS)MV
5	1.000	0.235	10	74,200	4.29	3,190,000	0.177	M(DS)MV
			Average	73,800	4.96	3,270,000	0.175	
			Std. Dev.	2,040	1.46	50,700	0.015	
			C.O.V. (%)	3	29	2	9	

MEASUREMENT OF THICKNESS FOR CURED IN PLACE PIPE LINER

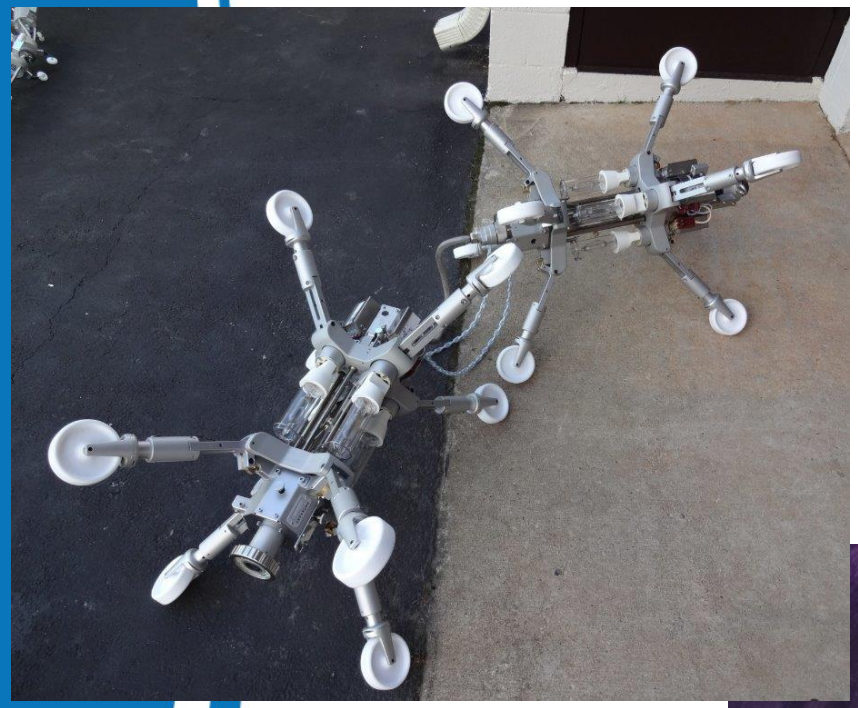
ASTM D5813

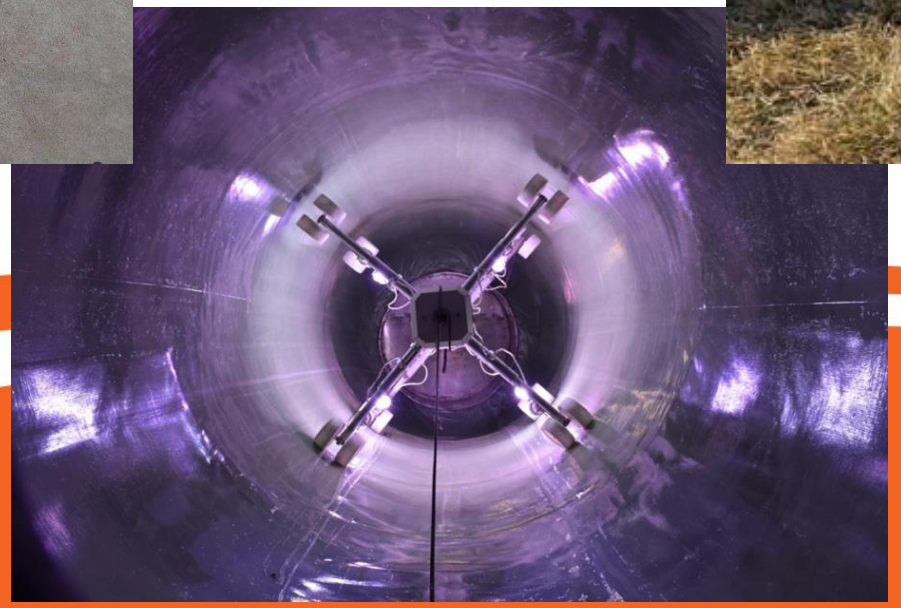
Sample ID	Manhole To Manhole	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	Combined Total Average/Specimen in	Mm
1		0.239	0.241	0.242	0.241	0.244	0.240	0.243	0.245	0.242	6.1

UV CIPP LINER INSTALLATION BENIFITS

Light Train Configurations 6”- 21”

Light Train Configurations 24”– 50”

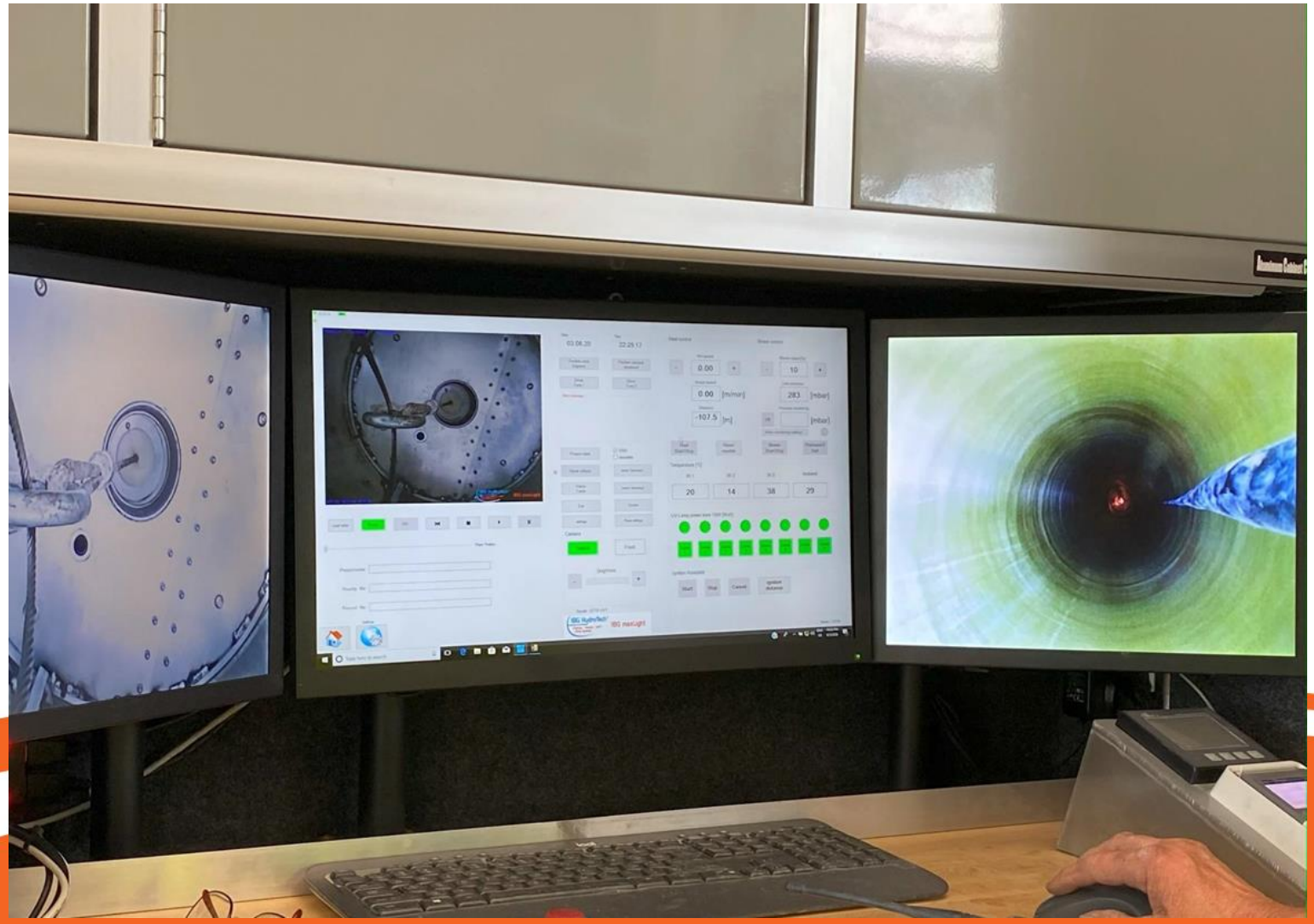




Expandable Legs

Integrated Camera

Control & Recording Protocols



Installation Benefits

- Trenchless Technology
- No Road Closures
- Minimal Traffic Control and Detours
- No Refrigeration
- 6-month shelf life
- The ability to inspect the inside of the liner before curing and during curing
- Pull in place process
- Easy to calculate cure times
- No resin slugging at laterals

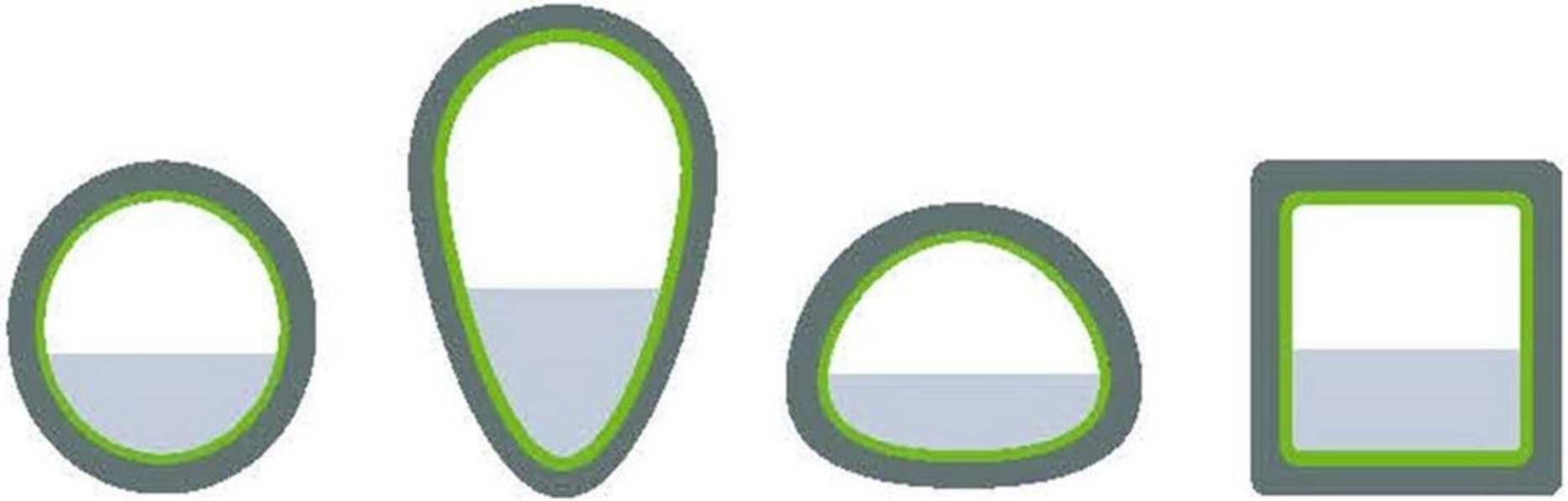
Environmental Benefits

- Cured using UV Light
- Environmentally Friendly Process
- No Styrene Odors
- No resin washout
- Liner resin is fully encapsulated leaving no contaminants in soils or area waters.
  - No discharge of styrene laden water
- Up to 90% less fuel consumed
- Small carbon footprint
- Quick installation time

End User Benefits

- Small to Large Diameters 6" to 72"
- Designed to be a STAND-ALONE pipe
- Thinner wall profile
- Uniform wall thickness
- High Strength 5 – 7 times stronger than other methods
- Flexural Modulus - Short Term 2,200,000 psi
- Flexural Strength - Short Term 20,000 - 30,000 psi
- Less disruption to the public
- Increased Hydraulic Capacity
- Small work area
- Ability to line Horizontal and Vertical host pipes.
- Capable of Lining Various Shapes, Sizes, & Types
- Extends the life of the pipe for at least another 50+ years!

Accommodates circular and non-circular pipes



Pipe Configurations

Beacon Hill, Boston 1700's Brick

BEFORE

Beacon Hill, Boston 1700's Brick

AFTER

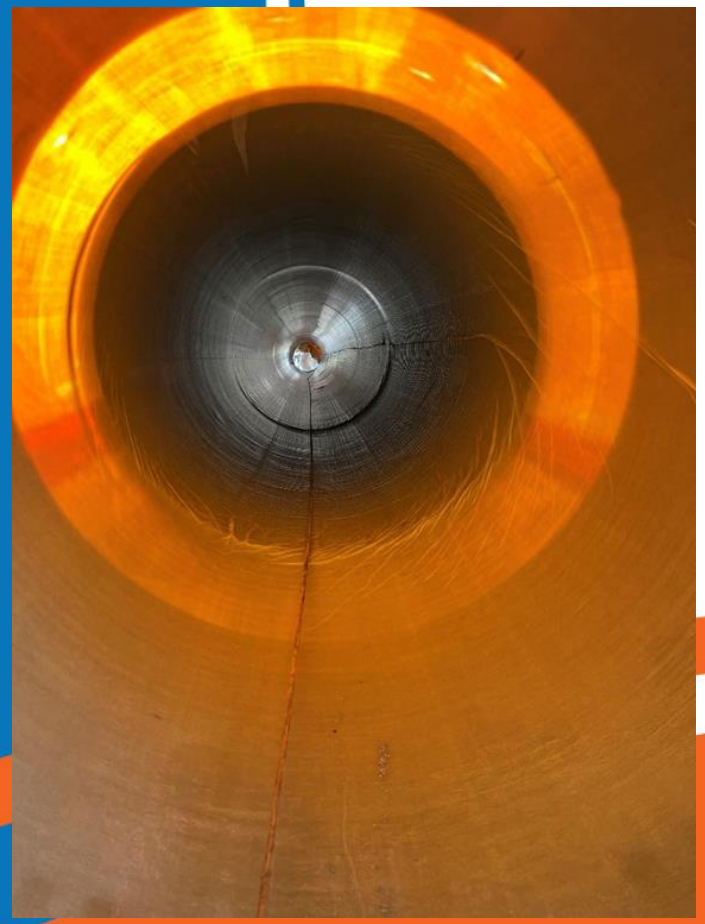
UV Liner Installations

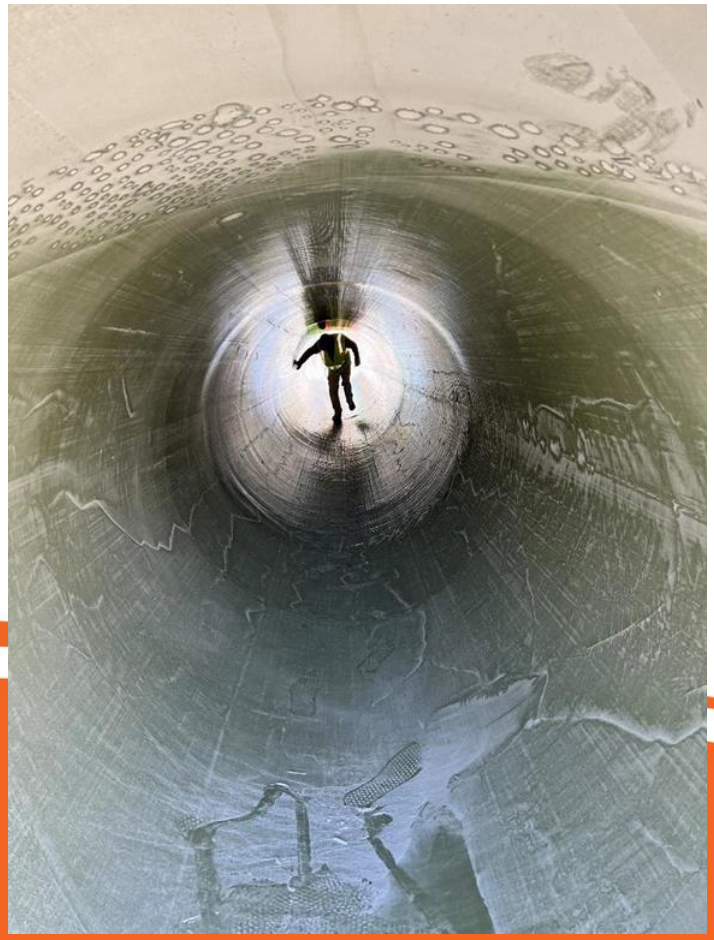
18” Omega Liner New Hampshire

CMP w/ Deteriorated Invert

Omega UV Liner Installation Projects

54” Omega Liner Installation - Nevada



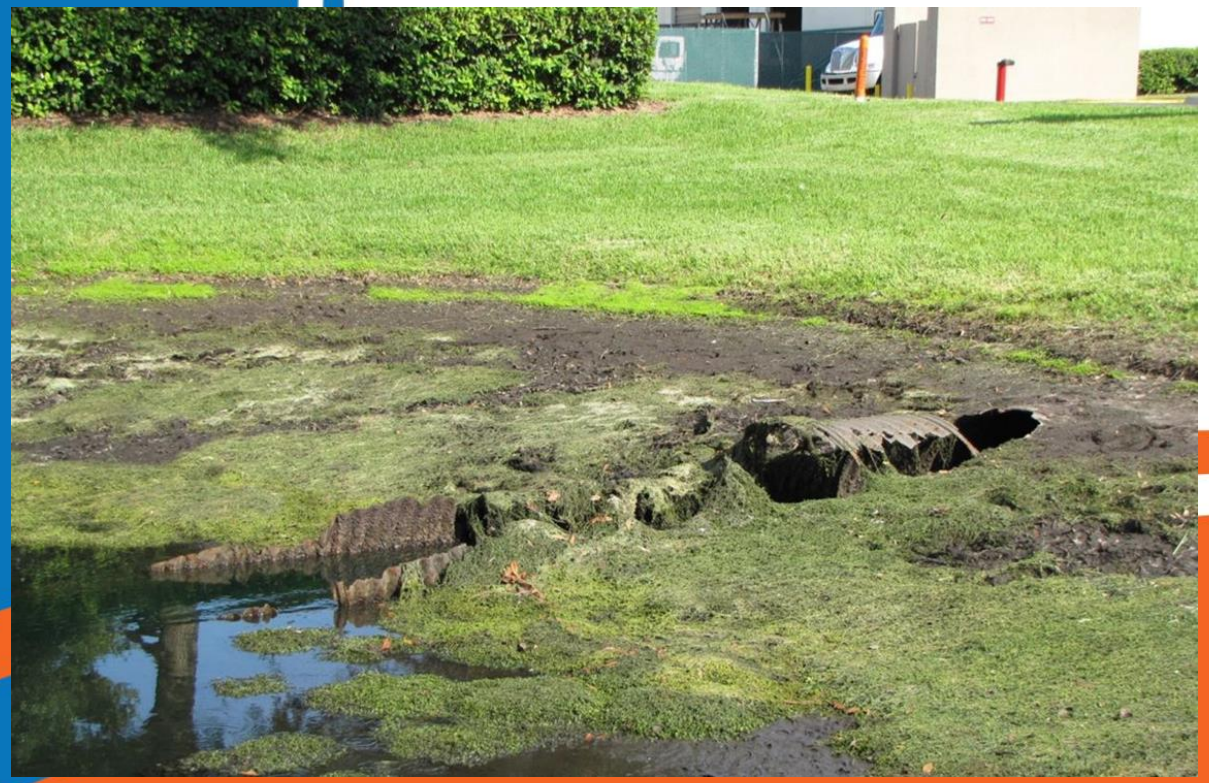


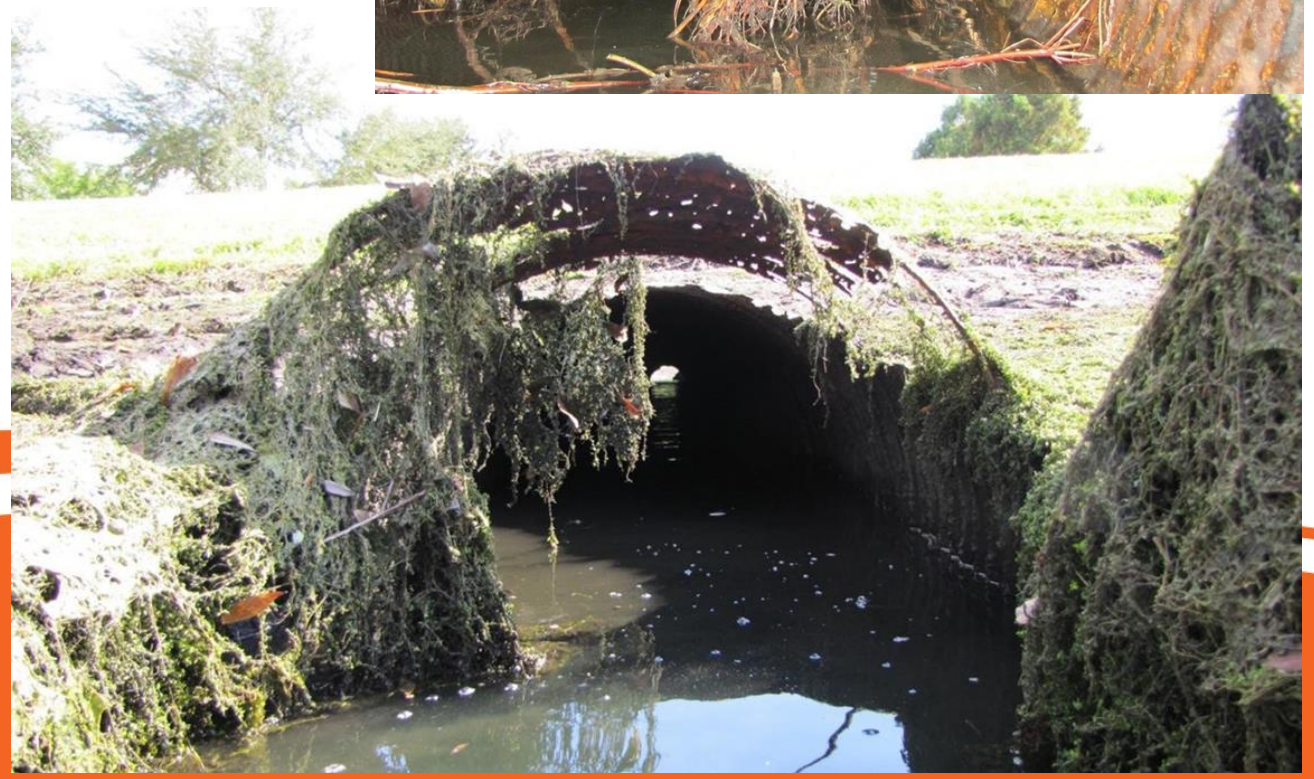
Twin 48” Omega Liner Installation - Tennessee

60" Liner Installation - SD DOT

36” Liner Installation

BEFORE





https://vimeo.com/1002903057/65500afbc0?share=copy

QUESTIONS??

Thank You! Brian Glaeser

920-816-8590 Brian@subsurface-inc.com