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The Inspector is the Gatekeeper to Successful CIPP Applications And Long-term Performance

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ABSTRACT

Most utility owners and specifying engineers are familiar with cured-in-place pipe (CIPP), but seldom does the owner, engineer or their onsite inspector possess the knowledge necessary to ensure the contractor constructs the new CIPP in accordance with the manufacturer's recommended practices and industry standards as described in the specifications. The thought that the CIPP is made in a controlled industrial facility is only half correct, as the new pipe is actually constructed by the insertion of a resin saturated liner tube that meets specific installation methods and specifications. Regardless of the extensive QA/QC that goes into the manufacturing of a liner tube and the resin saturation process, it becomes a moot point if the field installation does not meet the minimum level of quality. When this occurs, the service life of the repair is greatly reduced, and, often, the rate payers continue to pay for leakage and are plagued with maintenance issues that could have been prevented by having an inspector who is trained and certified in the proper inspection of CIPP.

INTRODUCTION

Cured-in-Place Pipe or better known as CIPP, a multi-billion dollar industry, has become the preferred choice of municipalities, utilities and owners of collection systems to rehabilitate their underground pipelines and conduits of every configuration. In fact the popularity and flexibility of the CIPP technology, has resulted in identifying solutions for almost any pipeline or conduit that requires repair or rehabilitation. Many factors contribute to this popularity including lower pipeline rehabilitation cost, lower disruption to the public and adjacent pipeline infrastructure, reduction of sewage overflows, contributing pollution to public waterways and rivers.

A typical CIPP installed inside of an existing pipeline

Cured-in-place pipe (CIPP) was developed in England in the early 1970's. Brought to the United States in the mid-to-late 1970's and developed through a system of licensed contractors in the 1980's. The CIPP became commercially accepted, by the industry, in the early 1990's. The technology today is offered, to the Customer, by integrated and tested systems as well as over the counter commodity materials. Both contractors and plumbers install the CIPP technology in a wide variety of pipeline systems including: mainlines, lateral pipes and manholes.

Today, there are hundreds of crews in North America and around the world installing CIPP technology for municipal, industrial, utility and private applications. Much of the success of the technology is attributed to no digging, minimal disruption of traffic or people and faster and cheaper processing. The process can be made environmentally friendly or green.

Typical installation tools for mainline installation of CIPP

BACKGROUND

Conduits and pipelines have been constructed, for thousands of years, to convey water to population centers and to take wastewater away for disposal; thereby maintaining the high health standards of a community. Methods and

materials have changed over the last 40 years. Some have survived better than others. Pipelines, when constructed from less than adequate materials, unmaintained and allowed to provide service well beyond its expected or intended life, will in time deteriorate and ultimately fail. This deterioration and failure of our collection system has become a reality in the 21st century.

In the early 1970's in England, Eric Wood invented, developed and installed the CIPP technology. The concept is to use the old existing pipeline as a form to install and manufacture a new joint-less pipeline within the old pipeline. Though slip lining was a well-known concept at the time, the CIPP method resulted in a much closer fitting pipeline that only slightly reduced the inside diameter of the host pipe but, because of the smooth internal plastic surface, the CIPP actually improved the capacity of the old pipe.

Cured-in-Place Pipe is evaluated by most municipalities for pipeline rehabilitation/replacement before proceeding with excavation and replacement.

PRODUCT MANUFACTURE

The CIPP product is manufactured from a variety of materials including a highly absorbent cloth or felt material that is coated with a waterproofing surface. Several layers of absorbent cloth and coated felt are combined to create a liner tube with a thickness that meets the customers design criteria. The felt material is then fully saturated (typically at a rate of 85% resin to 15% felt material by volume) with a liquid thermosetting resin material to create a flexible liner that can readily be installed into an existing mainline, lateral or manhole and cured.

Once cured, the resin provides the structure of the cured CIPP unless reinforcing fabrics are added.

Typical Installation Techniques Used for Mainline, Lateral and Manhole CIPP

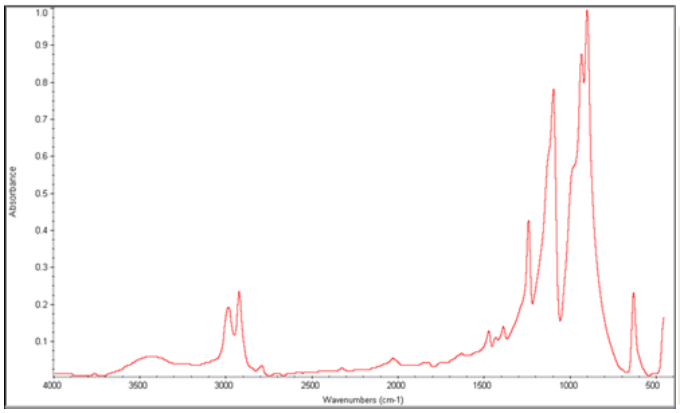
All of the materials are manufactured and typically fabricated in a factory environment under strict quality control standards. All aspects of the material fabrication are manufactured to ASTM or other industry standards that have been peer reviewed and approved as commercially viable product standards. This however is only the beginning of the CIPP process. The tube material, fully saturated with the specified quantity and quality resin, is then transported to the field for installation. Transportation of the material may vary for different materials. Heat cured liners will be refrigerated until installed in the pipe while ultra-violet liners are not sensitive to heat and will be protected by being fully wrapped in a UV protective film. However before the liner can be installed the existing pipeline or conduit must be prepared to accept the liner material to subsequently produce the cured-in-place pipe. Once the liner is inserted, under specified criteria, the resin material is activated with heat or light, depending on the resin furnished, to the manufacturer recommended curing schedule.

So what can go wrong in the field? Improper transportation causing defects curing, material shipped to project not in compliance with contract specification, existing pipe has not been adequately prepared to accept the liner material or the liner is not cured to manufacturer's recommended standards and ultimately does not meet the contract requirements and more.

To verify that the same quality is achieved during field installation as the factory produced materials, a trained and certified technology inspector is required. The inspector ensures that the same quality control that went into the manufacture of the CIPP materials is also used during field installation. The inspector is the gatekeeper for ensuring the long term design and service life of the product.

Inspection before and during installation ensures that the correct product quality, quantity and workmanship are delivered and result in predictable product quality after installation is complete in compliance with the contract requirements. Several of these inspection requirements include:

Resin Quality – resin quality information must be specified. Then verified through inspection, testing, submittals and field installation verification of wet-out reports.

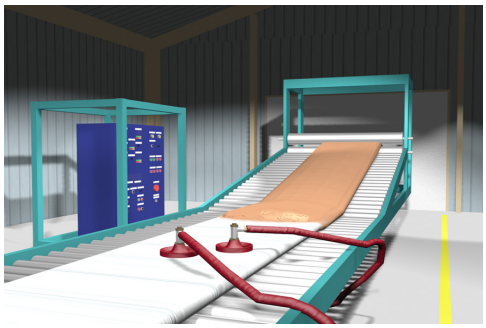


Fourier Transform Infrared Spectroscopy (FTIR) Resin Fingerprint

Resin used for CIPP

Resin Quantity – Resin liner saturation must be calculated, by the inspector, from wet-out reports submitted by the contractor and resin saturation charts submitted from the manufacturer.

Wet-out - 85% resin to15% felt ratio by volume

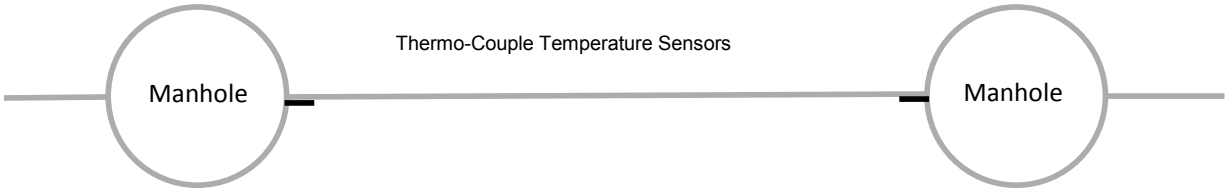


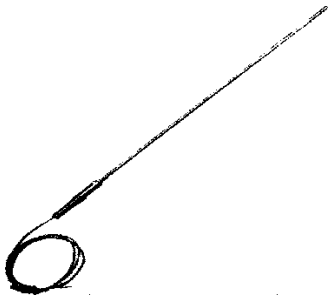
Typical Wet-out

Installation Quality – Existing liner condition must be inspected just prior to the contractor installing the resin liner to prevent lining, over defects, obstructions, and into pipelines not properly prepared to contract standards thereby preventing unwanted repairs of the newly installed CIPP.

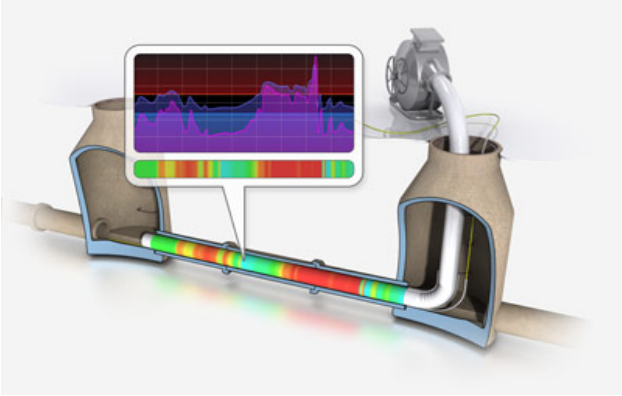
Figures 10, 11: Existing pipe being flushed and televised just before the liner installation

Liner Curing – Must be as recommended by the manufacturer. Using thermos-couple wires or sensor strips to record the entire liner cure from heat-up to cool down. A curing log must be produced and verified by the inspector.

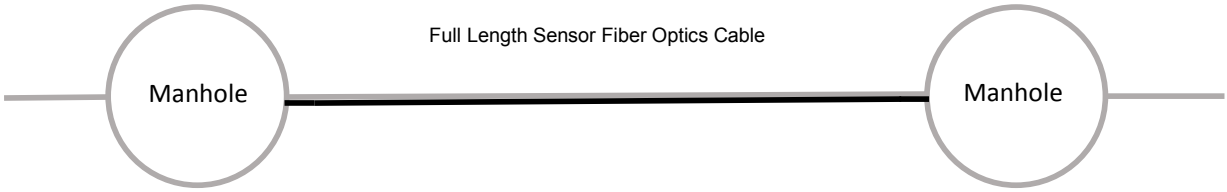




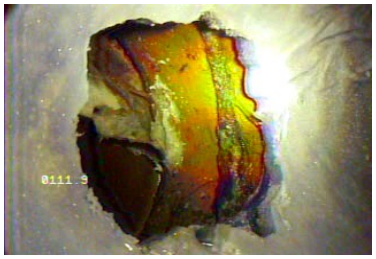
Typical thermo-couple measurement



Fiber-optics sensor strip measurement tool

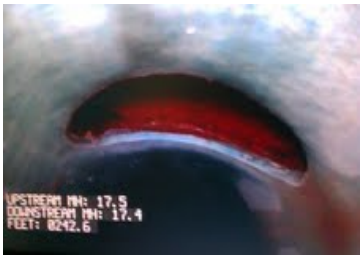


Service Reconnections – All connections must be re-opened to ASTM recommendations or contract specified requirements, including size and quality of the cut.



Poorly restored service connection

Quality restored service connection



CONTRACT DOCUMENTS

The contract documents should be prepared with sufficient detail, so that the contractor can readily understand and identify all aspects of the expected work to be constructed. This must include existing conditions fully detailed in the contract documents or provided in electronic format, such as DVD's and zip drives, with the bid documents. Detailed instructions on what level of quality, which is expected from the contractor, must be clearly defined; including the inspection and testing methods.

All product standards of quality must be defined in the contract documents including resin quantity and quality, pipe preparation requirements, manufacturers' recommended curing requirements and expected visual quality of all aspects of the installed product. All quality requirements that are specified must be measurable, then measured and documented by a trained inspector during installation.

The inspector is the gatekeeper for all inspection and testing requirements specified in the contract. The specifications must provide the instructions and processes required to measure the specified quality requirements. Therefore,

All quality requirements specified should be measurable and measured by the inspector before, during and after installation

CIPP INSTALLATION

The CIPP technology, whether installed in mainlines, lateral pipes or manholes must provide both a projected design life and a projected service life.

Projected design life - Represents the length of time that a product, correctly installed, is expected to protect the old pipeline from structural failure. With the first installation completed in 1971 and nearing 44 years of history the expected design life of a correctly installed CIPP liner can be expected to be 50 years and most likely the product should have a design life nearer to 100 years if not longer.

The service life – represents, in addition to structure, the length of time that a product will function for the intended service of the pipeline. If the pipeline experiences a high level of corrosion then the new CIPP must prevent the corrosion, of the pipeline for the same period as the design life. If the pipeline is suffering infiltration and the intended remedy is the installation of a CIPP, then the leakage, into the pipeline, must be stopped not only at time of project completion but for years in the future as required for the design life. How is this achieved? Some technologies require the product to bond to the old host pipe, after proper cleaning and preparation. Other products use engineered seal technology to provided long term leakage control and sometimes excavation and new construction is required.

Inspections must be performed at the completion of the installation and periodically to verify the products service life. This can be accomplished by further inspection and testing for structure, corrosion and leakage into the pipeline during and before expiration of specified or agreed to warranty periods. Therefore,

The CIPP installation must achieve a long term design life as well as a long term service life.

Typical Cured-In-Place

INSPECTOR CERTIFICATION TRAINING AND TOOLS

Installation inspection is required for cured-in-place pipe, including how a trained and qualified inspector can be a key factor or the gatekeeper for ensuring that a project is built to contract requirements and to the customer's quality expectations, while potentially resulting in higher profits for the contractor. The EPA in a recently published document

entitled “Quality Assurance and Quality Control Practices for Rehabilitation of Sewer and Water Mains” [1] states “Good QA/QC practices promote a healthy bid environment and ultimately lead to higher performing installations of trenchless technologies. Practitioners of a well-executed QA/QC program benefit from the overall lower cost of these improvements and the lower in-house costs of managing these assets over time. Contractors and technology vendors will respond accordingly to this call for quality once in place.”

Training for the inspection of trenchless rehabilitation projects has become a reality. Over the last few years utility owners have determined that trenchless rehabilitation requires the same professional design, construction and inspection as historically practiced with traditional public works projects. Therefore,

“Contractors and technology vendors will respond accordingly to this call for quality once in place” [1]

INSPECTOR TRAINING

Training and certification programs have emerged that provide technology training for the inspector. The inspector now has an opportunity to become trained and certified in a number of trenchless rehabilitation technologies including Cured-In-Place Pipe, Manhole Rehabilitation, Pipe Bursting and Directional Drilling. These programs are designed with the inspector and engineer in mind and their obligation to verify that a product has been installed correctly, meeting the design, service requirements and intent of the contract documents.

CONCLUSION

For an owner to obtain the best price and best quality for a CIPP project there must not only be a good engineering design with detailed performance specifications, an experienced construction contractor but also a trained inspector or gatekeeper on the project site.

The EPA document continues and states: “Better trained construction observers and the proper allocation of their time to monitor the installation process are key elements of a good QA/QC program” and concludes**,** “Successful QA/QC programs help to ensure that trenchless technologies will meet their designed service life expectations”.