

The Most Cost Effective Method for Eliminating Inflow

Larry W. Kiest, Jr¹

¹ LMK Enterprises, Inc. Intellectual Technology, Testing and Design
1779 Chessie Lane, Ottawa, IL 61350; PH (815) 433-1275; FAX (815) 433-0107;
email: linerbylmk@aol.com

Abstract: Manholes are a crucial part of the collection system. They serve as entryways to an extensive underground pipeline infrastructure. Today, the big picture is really the same as yesterdays and that is achieving the most cost effective and time saving methods for eliminating as much infiltration/inflow as possible.

By addressing and implementing renewal techniques for one of the most critical and obvious portions of the collection system, “the manhole chimney” the big picture becomes more obtainable. Manhole chimneys were typically constructed poorly with shims and small pieces of brick and mortar. This area is subject to freeze/thaw conditions in many geographical areas. Poor construction practices and freeze/thaw conditions are direct causes of faulty chimneys and have been identified as a crucial source of inflow.

Technology for renewing the vast network of pipelines and manholes is advancing with faster, more efficient, and more cost effective techniques. This paper will discuss new technologies for renewing and sealing the manhole chimney/ frame area using a (cured in-place manhole chimney liner). This paper will explain the simplicity of a one-size liner used to fit a host of various sized and configured manholes with minimal labor requirements.

Most importantly, this paper explains the stringent protocol carried out by a third party engineering/testing laboratory to extrapolate longevity of a renewed chimney that has been subjected to severe freeze/thaw cycles.

Various methods are available for sealing the chimney area. One in particular involves an inner rubber sleeve installed within the chimney area that extends up into the frame. This technology has been proven to be effective in eliminating inflow. However, this technology requires detailed measurement of each particular chimney and frame to be sealed. Further, it should be noted that a significant reduction in diameter occurs with this technology and as much as (3) inches.

Another system for sealing chimneys involves the installation of an exterior rubber sleeve. The application for this method requires excavation to expose the frame and chimney portion. There is no need for specific measurements each particular chimney and no reduction in diameter occurs with this method.

Cured in-place lining for sealing the chimney/ frame area of a manhole offers several positive attributes. These include structural enhancement, minimal reduction in diameter, as little as (1/4) inch, and a proven method for sealing and eliminating inflow.

It has been necessary to field measure each particular chimney in order to custom fabricate these linings. Though the cured in-place lining method for a chimney offers positive end results, the positive attributes may be overshadowed by the need to field measure each manhole chimney.

Technology for chimney sealing has advanced by use of a one-size liner that expands out to meet the frame and chimney portion without the need for field measuring. Several key elements are present in the design of this one-size chimney liner. The base textile is a key element in its expansion characteristics and whereby the sleeve is coated with an impervious membrane. This flexible coated textile sleeve is vacuum impregnated with a one-hundred (100%) solid silicate resin. The bonding strength and non-shrink properties of the silicate resin play a key role in the success of the one-size cured in-place chimney liner against inflow, even when subjected to repeated freeze/thaw cycles.

During the summer of 2005 a test simulating severe freeze/thaw conditions and its affects on the cured in place manhole chimney liner was conducted through a joint venture between the manufacturer and the certified installer. The test was witnessed and certified by a consulting engineer firm.

Test Procedure: The test procedure involved lining the chimney of a full-scale manhole test assembly. The manhole test assembly was constructed to allow the area surrounding the chimney to be filled with water. The entire test assembly was then placed in a large freezer with an ambient temperature of between negative fifteen (-15) and negative eighteen (-18) degrees F. After allowing the water surrounding the lined chimney to freeze, the test assembly was removed from the freezer and allowed to thaw. The test assembly was then placed back into the freezer, and the water surrounding the lined chimney was allowed to freeze again before the test assembly was removed from the freezer for the second time.

Manhole Test Assembly: A full-size precast concrete manhole concentric cone section was used as a base for the test assembly. A chimney was constructed on top of the cone section, consisting of two courses of un-mortared brick over one precast concrete extension ring. A manhole frame was installed on top of the chimney. (see Figure 1).

To simulate saturated ground conditions, a four (4) foot diameter, galvanized steel pipe section was set vertically over the top of the manhole section. The annular space between the steel pipe section and the outside of the manhole chimney was filled with clean crushed limestone. The crushed stone backfill extended below the manhole chimney, and was brought up to an elevation just above the lower edge of the manhole frame.

A flexible membrane liner was installed below the crushed stone backfill. The flexible liner was anchored to the manhole cone section beneath the precast concrete extension ring, ran down the cone section to the surrounding steel pipe, and then extended up and over the top edge of the surrounding steel pipe. The flexible liner allowed the crushed stone backfill surrounding the manhole chimney to hold water.

The entire manhole test assembly was set on a wood pallet. A flat bed trailer was used to transport the test assembly to and from the freezing and thawing site.



Figure 1. Constructing Manhole Chimney

Installation of CIP Manhole Chimney Liner: The manhole chimney liner is a non-pervious on one-side and a felt material on the side in contact with the manhole chimney. A two-component resin kit, pre-measured for the length of liner material to be installed, was mixed in a bucket. The resin/hardener mix was manually applied to the felt side of a pre-measured length of liner. (see Figure 2.) The application involved spreading the resin/hardener mix uniformly throughout the liner by moving a length of heavy steel pipe over the liner in a rolling-pin fashion. The liner material was then turned inside out and draped inside the manhole with the top few inches folded back over the manhole frame.



Figure 2. Installing Manhole Chimney Liner, Prior to Setting

A rubber bladder was placed inside the manhole and pressurized with air to 1.5 psi. The inflated bladder pressed the liner firmly against the chimney. The pressurized bladder was left in place for approximately two (2) hours. After the bladder was removed, the excess liner extending above the top of the manhole frame was trimmed off. The installed liner was continuous circumferentially and vertically, and appeared to be firmly adhered to the inside face of the manhole frame, chimney, and the top eight (8) to ten (10) inches of the angled wall of the manhole cone section.

Freeze/Thaw Test: The entire manhole test assembly was transported to a large underground freezer. Temperatures inside the freezer were maintained between negative fifteen (–15) and negative eighteen (–18) degrees F. After arriving and prior to placing the assembly in the freezer, water was added to the stone backfill surrounding the lined manhole chimney. The water was brought to a level just above the bottom edge of the manhole frame, causing the area surrounding the chimney to be completely filled with water.



Picture 3. Manhole Test Assembly with Flooded Backfill

The manhole test assembly was placed in Freezer Number sixty-one (61) on Thursday, August 11, 2005. The test assembly was removed from the freezer on Monday, August 15, 2005. The entire assembly, including the water surrounding the chimney, was obviously frozen. The manhole was observed on Tuesday, August 16, 2005 after thawing (see Figure 4). No changes in the condition or appearance of the chimney liner were noted. There were no signs of separation between the liner and the manhole frame, chimney, or cone section. There were no signs of leakage observed. Measurements were taken of the water level surrounding the chimney, and the measurements showed no measurable water loss.

The test assembly was returned to the freezer mid-day, Wednesday, August 17, 2005. The frozen manhole assembly was removed on Friday, August 18, 2005. The thawed manhole was transported to the testing site on Monday, August 22, 2005 for final observation. The chimney liner exhibited no change in appearance. There were no signs of separation between the liner and the manhole frame, chimney, or cone section. There were no signs of leakage observed. There was no measurable loss of water in the stone backfill surrounding the chimney.



Figure 4. Chimney Liner after First Thaw

Summary: The consulting engineers at the testing site observed the completed manhole test assembly after the manhole chimney liner was installed. We observed the test assembly as water was introduced to the crushed stone backfill surrounding the manhole chimney, and observed the test assembly as it was placed in the freezer the first time. We observed the test assembly when it was removed in a frozen state from the freezer, and again following thawing. We then observed the test assembly once it had thawed after being frozen a second time.

It is our observation that, following two freeze/thaw cycles, that the manhole chimney liner showed no change in appearance or condition. The liner appeared to be tightly adhered to the manhole frame, chimney and cone section at the conclusion of the field testing. No evidence of leakage through the chimney was observed during or at the conclusion of the test.

References

- Allgeier, Martin and Associates (2005)
Joplin, Missouri
Americold Logistics (2005)
Carthage, Missouri