



DENVER

THE MILE HIGH CITY

CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS | ENGINEERING DIVISION

Storm Drainage and Sanitary Sewer Construction Detail and Technical Specifications

10.8 Formed-In-Place PVC Trenchless Repair Method

10.8.1 General

This section defines the approved materials and methods for the rehabilitation of existing sewer pipelines by the use of a Formed-In-Place PVC pipeliner for pipes four (4) inches to fifteen (15) inches in diameter.

The Formed-In-Place PVC pipeliner process is defined as the rehabilitation of gravity sanitary sewers by the insertion of a folded PVC pipeliner which is formed into a circular liner to support and protect the existing pipe. The liner is reformed to fit the host pipe by the use of either steam or hydrostatic head. When cured, the finished Formed-In-Place PVC liner shall be continuous and tight fitting.

10.8.2 Methods

All bidders purposing to use the Formed-In-Place PVC process for a project must use a method that has been approved by the Engineering Division prior to bid opening. All approved methods must meet these Detail and Technical Specifications. Any proposed deviation from the Detail and Technical Specifications must be submitted in writing for acceptance at least eight calendar days prior to the bid opening.

There will be no deviation from the Formed-In-Place PVC pipeliner thickness specified.

10.8.3 Referenced Standards

This specification references American Society for Testing and Materials (ASTM), which are made part hereof by such references, and shall be the latest edition and revision thereof. All material, manufacturing, operations, testing, inspection and production of Formed-In-Place PVC Liners shall conform to the following referenced standards:

- ASTM D638 Standard Test Method for Tensile Properties of Plastics.
- ASTM D790 Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics.
- ASTM D792 Standard Test Method for Density and Specific Gravity of Plastics by Displacement.
- ASTM D1784 Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
- ASTM D2122 Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings.
- ASTM D2152 Standard Test Method for Adequacy of Fusion of Extruded Poly (Vinyl Chloride) (PVC) Pipe and Molded Fittings by Acetone Immersion.
- ASTM D2444 Standard Test Method for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight).
- ASTM D2990 Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics.
- ASTM F1057 Standard Practice for Estimating the Quality of Extruded Poly (Vinyl Chloride) (PVC) Pipe by the Heat Reversion Technique.
- ASTM F1504 Standard Specification for Folded Poly (Vinyl Chloride) (PVC) Pipe for Existing Sewer and Conduit Rehabilitation.
- ASTM F1947 Standard Practice for Installation of Folded Poly (Vinyl Chloride) (PVC) Pipe into Existing Sewers and Conduits.

10.8.4 Submittals

The Contractor shall furnish engineering data covering design and installation. Submittals shall be sent to the Project Construction Engineer for approval prior to the start of construction, unless noted otherwise. The data to be submitted shall include the following:

10.8.4.1 Liner Vendor Technical Data

The Contractor shall submit the Vendor's specific technical data with complete physical properties and pertinent dimensions for the proposed project.

The pipeliner shall be sized such that when reformed, it will fit tightly against the internal circumference of the original sewer conduit. The Contractor shall take necessary

measurements in the field to properly size the liner and shall verify the length of the pipe to be lined prior to ordering the liner.

10.8.4.2 Certificates

A certificate of “Compliance with Specifications” shall be furnished for all materials supplied.

10.8.4.3 Work Plan

The Contractor shall submit a work plan that lays out the execution of the project from start to finish. The work plan shall include, but is not limited to site access, site preparation, traffic control, bypass pumping, pre-installation preparation and testing.

10.8.4.4 Installation

The Contractor shall submit information about the procedure and the steps to be followed for the installation of the Formed-In-Place PVC pipeliner method selected, even if the process is named in the specifications. Any proposed changes in installation procedures shall require submittal of revised procedures for acceptance by the Project Construction Engineer. The installation submittal shall also include minimum and maximum allowable pressure and temperatures from the liner manufacturer so as not to damage the tube during liner reforming.

10.8.4.5 Resin and Other Components

The Contractor shall submit full details about the resin and other component materials and their properties, except those protected by trade secrets which may harm their claim to the product.

10.8.4.6 TV Tapes

The Contractor shall submit all post TV tapes in VHS format or streaming video on CD to the Project Construction Engineer for acceptance prior to payment.

10.8.4.7 Long Term Performance Studies

Submittals shall include long term performance studies of material from universities, and/or research institutes, and/or independent laboratories, using applicable ASTM standards.

10.8.5 Formed-In-Place PVC Trenchless Process Technical Supervision

Due to the technical aspects and complexity of specifications for the products used during the installation for the approved Engineering Division Formed-In-Place PVC Trenchless Repair (Fold and Form) Methods of Rehabilitation, the Contractor is required to maintain a full time employee with a minimum of three years experience in the Formed-In-Place PVC Trenchless Repair (Fold and Form) Methods of Rehabilitation. This employee should be at the superintendent level or higher. Resume and references of this employee shall be submitted to the Project Construction Engineer for review and approval prior to the start of the project.

10.8.6 Formed-In-Place PVC Material and Physical Property Requirements

10.8.6.1 Material Specifications

The PVC pipeliner shall be manufactured from virgin PVC resin, which has no fillers, and has the following minimum physical properties:

Minimum Pipe Stiffness at 5% Deflection

PIPE SIZE in. (mm)	PIPE STIFFNESS, psi (kPa)					
	PS-1	DR 35	PS-2	DR 35	PS-3	DR 35
	for material with a minimum cell classification of 13223-B [280,000 psi (1.93 GPa) minimum modulus]		for material with a minimum cell classification of 12334-B [320,000 psi (2.21 GPa) minimum modulus]		for material with a minimum cell classification of 12344-B [360,000 psi (2.48 GPa) minimum modulus]	
8 to 15 (203 to 381)	31 (219)		36 (250)		41 (285)	

Rounded Pipe Flexural Properties

Cell Classification	Flexural Modulus, psi (GPa)
13223-B	280,000 (1.93)
12334-B	320,000 (2.21)
12344-B	360,000 (2.48)

10.8.6.2 Linear Physical Properties Before and After Lining

The outside diameter and minimum uniform thickness shall be manufactured to a size that when installed will fit the internal circumference of the pipe and ensure the pipeliner’s ability to attain a tight fit. Allowance shall be made for misaligned and missing conduit.

A Standard Dimension Ratio (SDR) of 35 is required of all pipeliners, unless otherwise approved by the Project Construction Engineer. The following table shows recommended size ranges.

Folded Pipe Nominal Outside Diameter In. (mm)	Recommended Existing Pipe Inside Diameter Range In. (mm)		Resulting DR over Diameter Range
	Minimum	Maximum	DR 35
8 (203)	7.4 (188)	8.4 (213)	32-40
9 (229)	8.3 (211)	9.4 (239)	32-40
10 (254)	9.3 (236)	10.5 (267)	32-40
12 (305)	11.3 (287)	12.8 (325)	32-40
15 (381)	13.9 (353)	15.7 (399)	32-40

Note: The minimum and maximum recommended existing pipe inside diameter shown in the above Table are mean inside diameters along the pipe length and are not intended as absolute limits on localized dimensions. Consult the manufacturer for use of folded PVC pipe for sizes of existing pipe beyond the recommended ranges shown. Special diameters and DR available.

The pipeliner must be capable of lining bends, like those created by offsets, up to 90 degrees without vertical buckling or ripping.

No degradation of the pipeliner’s physical properties may occur due to processing or during installation.

The final product of the reconstructed pipe shall be a continuous pipe without joints, over the entire length of the pipe between two manholes. The Contractor shall verify the liner lengths required in the field prior to manufacturing. Individual insertion runs can be made through more than one manhole section at a time as determined in the field by the Contractor and approved by the Project Construction Engineer.

The pipeliner shall be free from reverse curvatures, flat spots and visual defects. The lining shall be impervious and free of any leakage. The inner surface of the pipe shall be free of cracking and have a smooth finish. The Project Construction Engineer will not allow any imperfections which may affect the flow characteristics of the sewer pipe.

10.8.6.3 General Corrosion Requirements

The Formed-In-Place PVC liner shall be fabricated from materials which, when cured, will be chemically resistant to, and able to withstand exposure to conditions that normally occur in sewer conveying domestic sewage. That includes exposure to hydrogen sulfide gas and dilute sulfuric acid.

10.8.6.4 Markings

The pipeliner shall be marked at maximum five (5') foot intervals with a coded number system to indicate manufacturer, size (diameter and SDR), material, extrusion date, and production shift that fabricated the pipeliner. The marking code shall be changed with each production shift change.

10.8.6.5 Shipping and Handling

Pipeliner shall be coiled continuously for the length of the proposed extrusion (no joints) on wooden reels with a minimum of a 48" diameter core for protection from kinking and gouging during shipping, handling, and storage.

10.8.7 Quality Control

10.8.7.1 Material Testing

Each production spool of pipeliner shall be inspected and tested at the time of manufacture for defects, in accordance with ASTM D-2444, ASTM D-2152, and ASTM D-2122. All pipeliner shall be homogeneous, uniform in color, free of cracks, holes, foreign material, blisters, and deleterious faults. A production spool of pipeliner shall include markings to clearly discern from other production spools.

10.8.7.2 Allowable Pulling Force

The Contractor shall inform the Project Construction Engineer as to the maximum allowable force that can be used in pulling the tube into the pipe without rupturing or diminishing the diameter and/or the thickness of the tube. Such pulling force shall be monitored at all times during the insertion operation and the tube shall be rejected and removed if the allowable pulling force is exceeded.

10.8.7.3 Allowable Elongation of Flexible Tube

Prior to insertion, the flexible tube shall be measured and marked equal to the insertion run (distance between manholes less one manhole diameter). After the completion of insertion, the length of the flexible tub outside of the insertion run (face of the manhole to the mark) shall be measured. This length or elongation shall not exceed 3% (three percent) of the original length of measured flexible tube. In the event that this length is exceeded, the entire run length may be rejected and permanently discarded, the Project Construction Engineer may order an additional tube to be inserted at no cost to the City, or the Project Construction Engineer may accept the elongated tube, but reduce the price paid for the work by 5% (five percent) for every percent elongation above the 3% (three percent) allowable tolerance, as

provided by General Condition 304, Substituted Performance. The acceptance of one of these will be at the sole discretion of the Project Construction Engineer.

10.8.7.4 Laterals and Services (Taps) Reconnection

The Contractor shall determine if a service connection is active prior to rehabilitation of the sewer. Only active service connections and laterals shall be re-established. The Contractor shall be responsible for completing point repairs of any active service connection that is opened and misaligned. This point repair shall be as directed and approved by the Project Construction Engineer.

10.8.8 Installation Responsibilities for Incidental Items

10.8.8.1 Access Points

The Engineering Division will endeavor to locate and designate all manhole access points, open and make access points available to the work.

10.8.8.2 Cleaning of the Sewer Line

The Contractor shall be required to remove all internal debris from the sewer line with the use of water jet equipment.

The cleaning operation shall remove any and all debris so that each joint pipe can be thoroughly inspected and successfully reconstructed.

All sludge, dirt, sand, rocks, grease, and all other solid or semi-solid material resulting from the cleaning operation shall be removed at the downstream manhole of the section being cleaned. Passing material from one manhole section to another shall not be permitted.

All such debris resulting from cleaning operations shall be removed from the site and disposed of in the proper manner. The Contractor shall bear all costs associated with testing of debris and proper dumping unless provided for elsewhere in the Contract Documents. Dumping of the debris shall be in accordance with all local, state, and federal regulations.

All debris shall be removed from the downstream manhole and the site no less often than at the end of each workday. No debris shall be left at the site unattended by the Contractor. Under no circumstances will be the Contractor be allowed to accumulate debris beyond the stated time. In the event the Contractor leaves debris unattended at the site beyond the stated time, the Contractor will not be allowed to proceed with the work until the debris is properly removed.

During all sewer cleaning operations, satisfactory precautions shall be taken to protect the sewer lines from damage that might be inflicted by improper use of cleaning equipment. Precautions shall be taken to ensure that the cleaning operation will not cause any damage or flooding to public and/or private property being served by the sewer line section involved. The Contractor shall bear full costs associated with any flooding or damage to basements or structures.

10.8.8.3 Bypassing Sewage

The Contractor shall provide for the flow of sewage around the section or sections of pipe designated for reconstruction. The bypass shall be made by plugging the line at an existing upstream manhole or adjacent system. The pump and bypass lines shall be of adequate capacity and size to handle the flow. Bypassing includes all mainline and service line bypassing required. Wastewater shall not be allowed to spill into storm drains, street gutters, or open excavations. Any spills that occur must be taken care of properly and immediately. The Project Construction Engineer shall be notified immediately and the Contractor shall bear all costs associated with any spills.

10.8.8.4 Inspection of Pipelines

Inspections of pipelines shall be performed prior to liner insertion by experienced personnel trained in locating breaks, obstacles, and service conditions by closed circuit television. The inspection of pipelines is also to determine active service connections and the addresses which they serve. The interior of the pipeline shall be carefully inspected to determine the location of any conditions which may prevent proper installation of the pipeliner into the pipelines, and it shall be noted so that these conditions can be corrected. A videotape and suitable log shall be kept for later reference by the Engineering Division.

10.8.8.5 Line Obstructions

It shall be the responsibility of the Contractor to clear the line of obstructions such as solids and roots that will prevent the insertion of the pipeliner. If pre-installation inspection reveals an obstruction such as a protruding service connection, dropped joint, or a collapse that will prevent the inversion process, and it cannot be removed by conventional sewer cleaning equipment, then the Contractor shall make a point repair excavation to uncover and remove or repair the obstruction. Such excavation shall be approved in writing by the Project Construction Engineer prior to the commencement of the work and shall be considered as a separate pay item as provided in the Proposal Forms or by Change Order.

10.8.8.6 Additional Convenience Manholes

The Contractor may be allowed to add manholes to the existing lines, for the convenience of manipulation during installation, at no cost to the City and County of Denver, at the sole discretion of the Project Construction Engineer.

The Contractor will be allowed to add manholes only if the **Traffic Control** requirements are not violated, and all materials, equipment, and work required to complete the additional manholes (including surface restoration) is in accordance with these Detail and Technical Specifications and Capital Project Management Standard Details.

10.8.8.7 Laterals and Services (TAPS) Reconnection

All lateral connections shall be provided with a water tight connection between the new rehabilitated pipeliner conduit and the old service connection. During construction and within the warranty period, after the laterals and services (taps) connections have been reactivated, if in the opinion of the Project Construction Engineer there is a gap between the

liner and the host pipe, the gap shall be sealed to the satisfaction of the Project Construction Engineer. The Contractor shall submit and obtain approval from the Project Construction Engineer for the material and the method used to seal the connection. No additional payment will be made for this work.

The Contractor shall determine if a service connection is active prior to rehabilitation of the sewer. Only active service connections and laterals shall be re-established. The Contractor shall be responsible for completing point repairs of any active service connection that is opened and misaligned. This point repair shall be as directed and approved by the Project Construction Engineer.

10.8.9 Public Relations

The Public Information and Notification program shall at a minimum, require the Contractor be responsible for contacting each home or business affected by the sanitary sewer construction and informing them of the work to be done in all of the following ways:

1. Written notice shall be delivered to each home or business describing work, schedule, how the construction affects them, and a local telephone number of the Contractor they can call to discuss the project or problems, that may arise.
2. Personally contacting each home and business owner on the day of pre-installation inspection of the sewer and coordinating with that owner the verification of their existing service connection. If the owner is unavailable, other arrangements shall be made for existing service connection verification.
3. Personally contacting each home or business owner and providing written notice the day prior to beginning work on the section of sewer to which they are connected.
4. Personally contacting any home or business owner which cannot be reconnected within the time stated in the written notice.
5. If required, portable toilets shall be furnished and serviced by the Contractor for businesses affected by construction. The costs of these items are considered to be included in the cost of CIPP. No additional payment will be made by the City.
6. A complete Public Information and Notification Program shall be submitted in writing to Project Construction Engineer.

10.8.10 Installation Procedures

Installation instructions and procedures submitted and approved for the project shall be followed during installation. Any proposed changes in installation procedures shall be submitted to the Project Construction Engineer for approval, prior to installation.

10.8.10.1 Liner Insertion

The pipeliner shall be inserted into the existing sewer with a power winch and steel cable connected to the end of the liner by use of an appropriate pulling head. Length of the

pipeliner to be inserted at any time shall be governed by the winch drum capacity and winching power available, and consideration of the size and condition of the sewer.

The Contractor shall submit to the Project Construction Engineer the tensile strength of the liner at the recommended temperature of the liner prior to insertion, and the recommended pulling force to pull the liner in place.

Precautions shall be taken to prevent any damage to the liner as it is pulled in place. Once insertion is initiated, it is desirable to continue the pull at a rate of no greater than 5 to 10 feet per minute to completion.

A cable shall be strung through the existing conduit (and containment tube, if applicable) and attached to the folded pipe. The folded pipe shall be heated along the entire length and pulled, with a power winch unit and the cable, directly from the spool, through the insertion point, through the containment tube (if utilized) and within the existing pipe to the termination point. A dynamometer shall be provided on the winch or cable to monitor the pulling force. Pulling forces shall be monitored so as not to exceed the axial strain limits of the folded pipe material as recommended by the manufacturer.

After insertion is complete, the winch cable shall be secured at the termination end and the folded pipe shall be cut off at the insertion point and secured.

10.8.10.2 Liner Reformation and Processing

Temperature and pressure must be logged while reforming and processing and may be accomplished through suitable temperature and pressure gages placed at the insertion and termination points. Through the use of heat and pressure, the PVC pipeliner shall unfold and expand sufficiently to press against the wall of the existing sewer pipe, lock into joints, and form dimples at the services. Pipeliners shall produce visibly recognizable service dimples and shall visibly conform to joints in the host pipe to ensure a tight fit. The heat, pressure, and period of processing shall be in accordance with the manufacturer's recommendations for establishing a new thermoplastic memory. For PVC pipeliners, processing temperatures range from 225 to 235 degrees F, and pressures in the range of 5 to 10 PSI, but may vary based upon field conditions, and in no case shall ever exceed 15 PSI for protection of the host pipe.

The Contractor shall maintain pressure on the liner, the heat shall be discontinued, and cool air in sufficient volume shall be injected to reduce the temperature to below 90 degrees F before relieving pressure.

Air pressure and/or steam shall be used with a Safety Gas Detector to ensure that it does not reach the explosive limit.

Before the insertion process begins, the minimum and maximum pressure and temperature that was submitted for installation shall be posted on-site. Once the insertion has started, the pressure shall be maintained between the minimum and maximum pressures until the operation has been completed. The equipment shall be fitted with a pressure gage accurate to 0.01 psi. Should the pressure deviate from within the range of minimum and maximum

pressures, the installed pipeliner shall be rejected and the Contractor will remove and dispose of the tube at no cost to the City.

A complete log of the temperature, steam pressure, and the air pressure shall be maintained on the site and shall be furnished to the Project Construction Engineer after each insertion. If water is added, that pressure shall also be included.

Pressure testing shall be completed prior to reestablishing services.

10.8.11 Finish

The installed Formed-In-Place PVC pipeliner shall be continuous over the entire length of a segment insertion run from manhole to manhole and shall be free, as commercially practicable, from visual defects such as foreign inclusions, concentrate ridges, discoloration, pitting, dry spots, pinholes, delamination, varying wall thickness (within the bounds of the existing sewer pipe), and other deformities. Pipeliner with gashes, nicks, abrasions, or any such physical damage which may have occurred during storage and/or handling, which are larger/deeper than 10 percent (10%) of the wall thickness shall not be used and shall be removed from the construction site.

The installed Formed-In-Place PVC pipeliner shall meet the physical properties and leakage/pressure test requirements as specified.

10.8.12 Manhole Sealing and Benches

The PVC pipeliner by nature of the processing creates a tight seal at the insertion and termination points of the manholes. The PVC pipeliner within the manhole shall be neatly cut off at a minimum of 4 inches (4") away from the manhole wall. The invert in the manhole shall be a smooth continuation of the pipe(s) and shall be merged with other lines, if any. The channel cross-section shall be U-shaped and in accordance with the Engineering Division Detail and Technical Specifications. The side channels shall be built up with mortar/concrete to provide benches according with the Engineering Division Detail and Technical Specifications and Standard Details.

If due to broken or misaligned pipe at the manhole wall, the Formed-In-Place PVC pipeliner fails to make a tight seal, the Contractor shall apply a seal at that point with material compatible with the PVC pipeliner.

All manholes shall be individually inspected for water migration, cut-offs, benches, and invert works.

10.8.13 Service Reconnections

Once the pipeliner has been reformed, processed and tested the Contractor shall reopen/restore the existing active service connections and branch connections. It is the intent of these specifications that active service connections and branch connections be reopened without excavation, from the interior of the pipeline utilizing a remotely controlled cutting device, monitored by a close circuit television camera, that re-establishes them to not greater than 100% (one hundred percent) capacity, and not less than 95% (ninety five percent) capacity, while conforming to the shape of the existing opening.

The service reconnection method proposed by the Contractor must be approved by the Project Construction Engineer.

The Contractor shall certify he/she has a minimum of 2 (two) complete working cutting devices, plus spare key components on the site before each insertion.

No additional payment will be made for excavations for the purpose of reopening connections and the Contractor will be responsible for all costs and liability associated with such excavation and restoration.

No service connection shall remain out of service for more than 24 hours at a time without the Contractor providing some means of temporary facilities or hotel accommodations for the residents.

10.8.14 Inspection of the Formed-In-Place PVC Pipeliner

Testing will be required after the pipeliner has been installed in the existing sewer pipe. The test is a low pressure air test of the Formed-In-Place PVC pipeliner before any service connections to the pipeliner have been made. The purpose of this test is to check the integrity of the pipeliner and to verify that the pipeliner has not been damaged when pulling it into the existing sewer pipe.

10.8.14.1 Physical Testing

Sample from each spool (or as directed by the Project Construction Engineer) shall be tested in a local lab. Formed-In-Place PVC Pipeliner shall be sampled and tested in accordance with Sections 10 and 11 of ASTM F1504, and the properties shall meet or exceed these specified herein (please refer to 10.8.6.1 Material Specifications).

10.8.14.2 Low Pressure Test

After a manhole to manhole section of the sewer pipe has been lined, it shall be plugged at each manhole with pneumatic plugs. The design of the plugs shall be such that they will hold against the test pressure without requiring external blocking or bracing. One of the plugs shall have three (3) air hose connections, one for inflation of the plug, one for reading of the pressure into the sealed line, and one for introducing air into the sealed line.

The test section shall be pressurized to 4 PSI and held above 3.5 PSI for not less than two (2) minutes. Air shall be added if necessary to keep the pressure above 3.5 PSI. At the end of this two (2) minutes stabilization period, the pressure shall be noted (must be 3.5 PSI minimum) and the time period shall begin. If the pressure drops 0.5 PSI in less time than given in the following table, the section of pipe shall have failed the test.

Sewer Size Inches	Minimum Test Time Minutes
8	4.0
10	5.0
12	6.0
15	7.5
18	7.5

When the prevailing groundwater is above the sewer lined pipe being tested, test pressure shall be increased 0.43 PSI for each foot that the water table is above the invert.

10.8.14.3 Visual Inspection

Visual inspection shall be done prior to rehabilitation and upon completion of the Project. The Contractor will provide the Engineering Division with the original color VHS video tape or streaming video on CD of each section of pipe involved in the Project and the cutsheets for same upon completion of the Project. The tape or CD will include both the before and after conditions, and restored connections with addresses each connection serves, in audio, on the video.

10.8.14.4 Infiltration Test

If the ground water level is above the top of the pipe throughout the length being reconstructed, and is so ordered by the Project Construction Engineer, an infiltration test shall be performed. See paragraph 9.2.2 of Section 9.0 of the Detail and Technical Specifications portion of these Specifications.

10.8.14.5 Exfiltration Test

In the absence of ground water, and if so ordered by the Project Construction Engineer, an exfiltration test shall be performed in accordance with paragraph 9.2.1 of Section 9.0 of the Detail and Technical Specifications portion of these Specifications. The allowable rate of exfiltration shall be equal to the limits of infiltration.

10.8.15 Reports

Copies of all certified reports and logs of all tests and inspections conducted shall be submitted to the Project Construction Engineer.

10.8.16 Clean-Up

Upon acceptance of the installation work and testing, the Contractor shall reinstate the project area affected by this operation.

10.8.17 Patents

The Contractor and the Contractor's supplier shall warrant and hold harmless the City and County of Denver against any and all claims and potential litigation involving patent infringement and copyright violations and any loss thereof.